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VOLUME LXXXVII.—1903.

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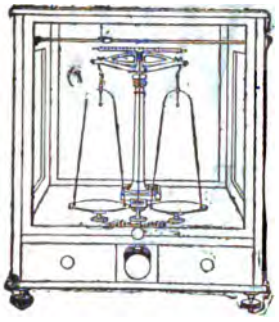

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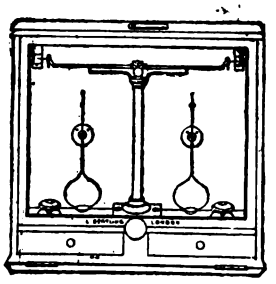

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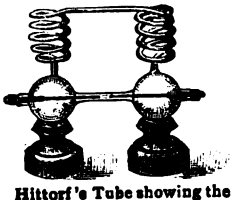

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VOLUME LXXXVII.

EDITED BY SIR WILLIAM CROOKES, F.R.S., &c.

No. 2249.—JANUARY 2, 1903.

THE DIRECT CONVERSION OF CHARCOAL INTO DIAMOND.

The Converse of Pepys' Experiment.

By Dr. ALBERT LUDWIG.

One of the most essential relations between electrical and radiant energy is expressed by a law of nature, according to which all transparent elementary bodies are non-conductors of electricity. I employed conformity to this law as a criterion of the possibility of converting carbon into its different forms. Thus, if by any process whatever charcoal is converted into diamond, this change must be recognised by the resulting non-conductivity of the carbon, which could be easily proved by suitable instruments. Further, I started from the assumption that in almost all cases an allotropic change may be effected by simple alteration of temperature, at ordinary or increased pressure. There is no instance in which, apart from chemical influences, any desired form of such an element cannot be obtained by raising or lowering the temperature. In all cases in which other bodies are favourable to the reaction, what actually occurs is only a lowering of the temperature of conversion. Thus, in the preparation of red phosphorus, iodine effects the change at a far lower temperature. In the present case, at a red heat iron enters into combination with carbon as diamond, and Pepys showed this by the change of a glowing iron wire brought into contact with diamond into steel. If it is required to change carbon directly into graphite, as is known, a very much higher temperature is needed. I was able to show that in all these reactions under strong gaseous pressure (pressures up to 3100 atmospheres were used) the formation of diamond results either at a lower temperature in presence of iron (red heat) or at the melting-point of carbon without using such a contact agent. An iron spiral was embedded in retort carbon powder, and heated to a red heat by an electric current in an atmosphere of hydrogen at high pressure. A few minutes after the current began to pass, the low resistance originally caused by the conducting carbon rose to the value of the resistance of the iron spiral. The charcoal in contact with the spiral had thus become a non-conductor. Careful examination showed on some of the little pieces of carbon bright glittering crystals with the specific properties (hardness, specific gravity, refraction) of diamond. A great part of the carbon present in the iron spiral was likewise changed into diamond. The characteristic appearance of these little crystals was worthy of remark; the strongly marked pitting of their surfaces calling to mind Moissan's diamonds. Undoubtedly, here the iron brought about the reaction which ensued at so low a temperature. If it is required to convert charcoal into diamond without the presence of iron, numerous experiments showed that it is necessary to melt the carbon in an atmosphere at very high pressure. In fact, it was successfully proved that molten carbon is non-conducting, and is thus diamond. At the gaseous pressures used in this case the carbon melts very easily by the help of a metallic arc lamp, and was thus obtained in small spheres, about the size of a pea, of great hardness, and having the crystalline structure of naturally occurring carbonados.

This reaction might obviously be used to prepare diamonds on a large scale, even to enter into competition with natural diamonds, if certain conditions must be maintained; these are easily fulfilled if sufficient means are at hand, and I shall return to this subject at the proper time.

I will here describe one more experiment which explains the non-existence in nature of silicon carbides. Powdered carbon was mixed with different silicates, and exposed for about fifteen minutes to the action of a strong arc (under strong pressure) generated by means of a 5 horse-power machine. A research performed by Fresenius, in Wiesbaden, showed that all the carbon was present in the free state. Thus the proof could be deduced that at the high gas pressures occurring at a temperature at which carbon is melted no carbide could be formed. An explanation of this peculiar behaviour of carbon ought not to be difficult to find (Gibbs and Helmholtz, "Law of Entropy").—*Chemiker Zeitung*, 1902, xxv., 89.

ON CERTAIN PROPERTIES OF THE ALLOYS OF THE GOLD-SILVER SERIES.*

By he late Sir W. C. ROBERTS-AUSTEN, K.C.B., D.C.L., F.R.S., and T. KIRKE ROSE, D.Sc.

In a former communication to the Society (*Roy. Soc. Proc.*, 1900, vol. lxvii., p. 105) the curve of the initial freezing-points of the alloys of gold and copper and some micrographic evidence as to their structure were given, and it was shown that, according to the theory of solutions, the alloys rich in gold should not be homogenous after they have solidified. The fact that they are not uniform was confirmed by analysis. The subject has, however, more than theoretical interest, and the inference was drawn that standard gold, which consists of eleven parts by weight of gold to one of copper, is unsuitable as a material for the preparation of the trial plates by which

* A Paper read before the Royal Society, December 11, 1902.

the standard of the coinage is tested. These trial plates according to law must contain 916·6 parts of gold and 83·3 of "alloy," that is of some other metal, and it remained to be determined what the other metal should be.

It will be at once apparent that the alloy or mixture of the two metals must, if the cold mass is to be uniform, solidify as a whole; that is to say, that the crystals first formed should be of the same composition as the mother-liquor, and this condition can be fulfilled by isomorphous mixtures only. It has long been recognised that the gold-silver alloys are cases of isomorphism, and Gautier, in 1896, stated (*Bull. de la Soc. d'Encouragement*, October, 1896) that the freezing-point curve of the series followed a straight line if the percentages by weight of the constituents were taken as abscissæ.

This curve was re-determined by experiment, a number of alloys being made up and autographic records taken of their cooling curves by the Roberts-Austen recording pyrometer. The results obtained are given in the following table. The freezing-point of gold was taken as 1064°.

Percentage of gold present in alloy.		
By weight.	In atoms.	Freezing-point.
100	100	1064°
80·99	70·25	1061
64·60	49·97	1061
54·80	39·89	1046
43·98	30·07	1044
31·71	20·28	1028
17·23	10·23	1001

The following points have been observed by Heycock and Neville (*Phil. Trans.*, A, 1897, vol. clxxxix., p. 69):—

2·26	1·25	962°
0·91	0·50	961
0	0	960

It will be seen that Gautier's conclusion is substantially confirmed, but it was observed, as one of us had previously pointed out (Roberts-Austen, *Proc. Inst. Mechanical Engineers*, 1891, p. 564), that the first additions of silver did not depress the freezing-point of gold. So far does this property extend that even the alloy containing 50 atoms of gold to 50 of silver, or 64·6 per cent of gold by weight, solidifies at 1061°, which is only 3° below the freezing-point of pure gold. With further additions of silver there is a steady acceleration in the rate of lowering of the point of solidification, so that the freezing-point curve of the series has no double flexure, unless one is indicated near the silver end of the curve by Heycock and Neville's results.

There is, of course, no eutectic alloy observable in any member of the series.

The alloys all consist of large grains, but these are built up of smaller grains, so that the ultimate structure is exceedingly minute. When magnified 1500 diameters the grains appear as small irregular crystals of the cubic system. In order to develop any segregation that might take place, an ingot of the standard alloy containing 91·66 per cent of gold by weight was heated for two months in one of the annealing furnaces at the Royal Mint, the temperature of which was kept at about 700° by day, but fell to about 100° at night. The maximum temperature attained was over 300° below the fusing-point of the alloy, and the sharpness of the angles of the specimen had suffered no change. After this treatment it was found that the grains had increased in size, and the crystals forming them had become well developed. No true segregation, however, could be detected even in this ingot, either by analysis or by the microscope, and plates prepared by rolling out ingots containing 916·6 parts by weight of gold, and 83·3 parts of silver, were found on analysis to be uniform in composition.

The ancient trial plates, according to the analysis made by one of us (Roberts-Austen, *Chem. Soc. Journ.*, 1874, p. 197), consist of a triple alloy of gold, silver, and copper. The earliest one in existence was made in 1527, the year following the first introduction of the standard 916·6. This plate contained only 0·62 per cent of copper, and was probably intended to consist of gold and silver only. All subsequent plates, however, down to that made in 1829, contained much larger amounts of copper. In 1873 it was determined to omit the silver and to use only copper as the alloying metal, and thus to preserve identity of composition between the trial plate made in that year and the coinage. In view, however, of the importance of obtaining homogeneous trial plates and of the ease with which the exact quantity of copper required to make the assay pieces identical in composition can be added to the pieces of the trial plate during the course of the assays, it is preferable to use only silver as the alloying metal in the manufacture of the trial plates.

Such an alloy has accordingly been used at the Royal Mint since the beginning of the present year instead of fine gold for checks in the assay of standard bars and coins. In view of the minute accuracy with which the operations of coinage have to be conducted, this is a matter of much importance. By this method any errors are avoided which might be caused by accidental variations in weights occurring after the trial plates have been made.

ABNORMAL CHANGES IN SOME LINES IN THE SPECTRUM OF LITHIUM.*

By HUGH RAMAGE, B.A., St. John's College, Cambridge.

IN the course of an investigation on the flame spectra of metals, the writer has examined the spectrum of lithium. Some facts have been discovered of sufficient importance for a separate paper.

The same spectrometer was used as in the investigation on the "Spectra of Potassium, &c." (*Roy. Soc. Proc.*, 1902, vol. lxx., p. 303). Whilst the wave-lengths of some of the lines in the flame spectrum of lithium agree closely with those given by Kayser and Runge for the lines in the arc spectrum (*Berlin Akad. Abhandl.*, 1890, vol. iv., p. 19), the wave-lengths of other lines differ considerably from these. The numbers and differences are given in the accompanying table.

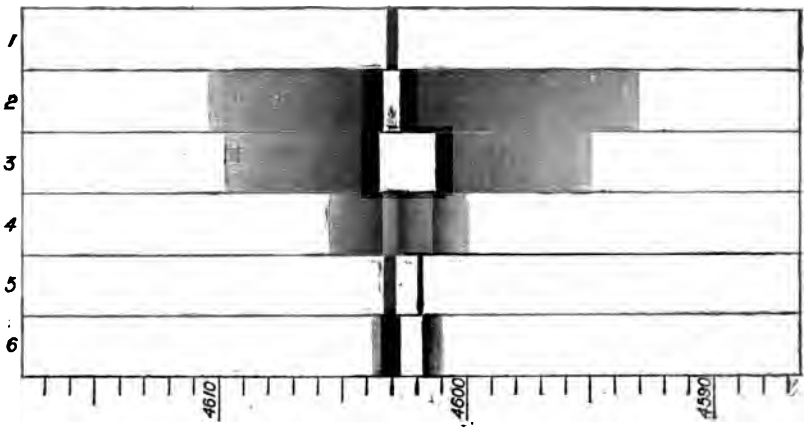
The only important differences occur in the lines of the first subordinate series. Exner and Haschek have given the wave-lengths of three lines in the spark spectrum (*Sitzber. Kais. Akad. Wien.*, 1897, vol. cvi., Abth. 2A, p. 1133) as 2815·55, 3232·91, and 4603·10. The last is described as reversed. Eder and Valenta have given the wave-length of the blue line in the Bunsen flame spectrum as 4602·4 (*Denkschr. Kais. Akad. Wien.*, 1893, vol. lx.), and as 4602·46 in the spark spectrum when a condenser was used (*Denkschr. Kais. Akad. Wien.*, 1898, vol. lxvii.). They described the latter measurement as that of the middle of a broad dark line, the less refrangible wing of which was stronger than the other, and diffuse towards the red. They also gave measurements of five other lines, and these agree closely with the arc lines given by Kayser and Runge. Professor Hartley recorded four lines in the oxyhydrogen flame spectrum of lithium chloride (*Phil. Trans.*, A., 1894, vol. clxxxv., p. 177) corresponding to the first, fourth, sixth, and eleventh of the lines in the above table. The blue line was measured in the flame spectrum on four plates, and the results differed only in the second decimal place, the figures in which were 8, 7, 6, and 7. Professors Liveing and Dewar made some observations by eye on the appearance of the blue line in the arc spectrum which led them to believe there were two lines, a strong one with a weak line on the more refrangible side (*Phil. Trans.*, 1883, vol. clxxiv., p. 215), and Kayser and Runge, after referring to this, say (*Ibid.*, p. 20):—"Wir

* A Paper read before the Royal Society, December 11, 1902.

Oxyhydrogen flame spectrum (Author).		Arc spectrum (Kayser and Runge).					
		Principal series.		Second subordinate series.		First subordinate series.	
Wave-length.	Intensity.	Wave-length.	Difference from flame.	Wave-length.	Difference from flame.	Wave-length.	Difference from flame.
6708	10	6708·2	—				
6103·84	9					6103·77	−0·07
4971·98	2			4972·11	+0·13		
4603·07	7					4602·37	−0·70
4273·34	1			4273·44	+0·10		
4132·93	5					4132·44	−0·49
3985·86	<1			3985·94	+0·08		
3915·59	3					3915·2	−0·39
3795·18	2					3794·9	−0·28
3719	1					3718·9	—
3232·82	4	3232·77	−0·05				
2741·43	1	2741·39	−0·04				

The flame lines are all sharp.

Kayser and Runge describe the lines 6708·2, 3232·77, 2741·39, and 6103·77 as "mostly reversed"; the lines in the second subordinate series as diffuse towards the red; the lines 4602·37 and 4132·44 as reversed; and the latter, with the remaining lines in the same series, as diffuse on both sides.



Diagrams of the Blue Lithium Line as it appears in Photographs.

The fine vertical lines are merely shading lines; the broad wings of the actual lines in the spectra are continuous.

1. Bright line of flame, arc and spark spectra.
2. Reversed line from dense outer flame of arc.
3. Reversed line from inner cone of strong arcs and from near negative pole of weak arcs.
4. Broad line with two absorption bands, from arc spectrum.

5 and 6. From spectrum of thin outer flame of arc with different exposures.

haben nur bei zwei Aufnahmen neben der Hauptlinie eine zweite schwache umgekehrte Linie bein 4603·13 erhalten; da aber hier eine Eisenlinie liegt, glaeben wir, dass dies eben die Eisenlinie ist, welche sich durch den hellen Hintergrund der Lithiumlinie umgekehrt hat."

The wave-length of the line which Kayser and Runge attributed to iron agrees with that obtained by the author for the bright line in the flame spectrum, and by Exner and Haschek for the reversed line in a spark spectrum. It was decided in view of these differences to take a series of photographs of the arc spectrum of lithium, using the carbonate of lithium on carbon poles, and to study especially the appearances of the blue line. The results will now be briefly described.

A Gulcher arc lamp with vertical carbons was used. When the arc was started with a quantity of lithium carbonate on the carbons, a large proportion of the salt was freely volatilised and expelled in the form of a dense vapour. As the arc lamp was placed, the magnetic field produced by the feed mechanism caused the bulk of the vapour to be expelled in the direction of the collimator. Photographs of the spectrum taken at this early stage show the line as a very broad bright line extending from 4610·4 to 4593·5, with a narrow dark line extending (2 in figure) from 4603·46 to 4602·71, having its middle (measured) at 4603·06. The middle of the broad bright line is, according to the above, at wave-length 4601·95, and the middle of the dark line (reversed) is coincident with the bright line of the flame spectrum.

One pole of a weak bar magnet was placed near the arc so as to direct the expelled vapour in a direction perpendicular to the axis of the collimator. After the large excess of the lithium salt had been volatilised, the image of the central portion of the arc was thrown on the slit, and the spectrum photographed, when the ends of the carbon poles, not widely separated, were red-hot. The lithium vapour in the central core was doubtless at a very high temperature, and there was only a thin layer of cooler vapour between it and the slit. Under these conditions the bright line is again broadly expanded, and so also is the dark line, for it now extends from 4603·55 to 4601·25 (mean = 4602·40) on one photograph (3 in figure), and from 4603·68 to 4601·22 (mean = 4602·45) on another. The bright wings are nearly of the same intensity and extent. The middles of these two dark lines are nearly the same as the wave-length 4602·37, given by Kayser and Runge, and by Eder and Valenta for the reversed lines.

Some photographs were also taken of the spectrum of the transparent flame which issued from the arc, the bar magnet being used as above. With a short exposure one

narrow bright line was obtained of wave-length 4603·06; with a longer exposure this bright line was much stronger, and there was the appearance of a weak line on its more refrangible side, exactly as Professors Liveing and Dewar described. The wave-lengths of these two were 4603·18 and 4601·89 respectively on one photograph (5 in figure), and 4603·12 and 4601·65 on another. The last line was fairly sharp on the less refrangible side, whilst it faded gradually on the other side (6 in figure). With still longer exposures the weaker line could not be distinguished from the wing of the much expanded bright line. This wing when weak always resembles a line, and it was thought that a line might be nearly coincident with its less refrangible edge. Measurements showed that this edge varied in position on different photographs, but Professor Liveing suggested that the tip might be formed by a line, and if so, the tip should always have the same wave-length. The following table gives the wave-lengths of the two tips on different photographs:—

Spectrum.	Tip of weaker side.	Tip of stronger side.
206[3]	4601·68	
213[4]	·83	4603·11
213[6]	·66	·11
214[1]	·72	·03
222[6]	·78	·10
222[7]	·82	·11
224[6]	·82	
226[5]	·83	
226[7]	·95	4603·21
232[6]	·79	

This evidence is not conclusive; both tips appear to vary, but the weaker one varies more than the other. The arc, in these experiments, was formed with a Gulcher lamp with the carbons vertical, the positive being uppermost, and the image of the arc projected on to the slit of the collimator by a lens. It was observed that the less refrangible point, wave-length 4603·1, was, in many photographs, higher on the plate than the weaker point; it was given out by vapour quite near to the positive pole. It was observed also in some photographs that the line extending from it faded away lower down; the vapour near the negative pole did not emit this line, but gave the broad bright line with the broad dark line down its middle. This broad bright line fades away as the positive pole is approached; the more refrangible wing ends in a point, but the less refrangible wing is lost in the bright line of wave-length 4603·1. There appears then in the middle portion of the spectrum a broad dark line with wings of unequal extent, and the less refrangible wing is broader, and, near its more refrangible edge, much stronger than the other wing. The broad dark line extended on such photographs from (1) 4602·72 to 4601·81, (2) 4602·86 to 4602·05, (3) 4602·73 to 4601·62, and in two other cases, where there were less differences of intensity between the two wings, from 4603·26 to 4601·61 and from 4603·07 to 4601·59. There were indications on some photographs of a bright line near the middle of the broad dark line; the measurements of such a photograph gave:—

Less refrangible edge of broad dark line ..	4603·40
Apparent bright line	4602·57
More refrangible edge of broad dark line ..	4601·31

The absorption bands of reversals in such a photograph as this are comparatively bright, for there is considerable action on the plate where the images of these bands fall (4 in figure). The effect is probably due to the superposition of the spectrum of the outer flame upon that of the inner core when both are giving reversed lines.

Some observations were made at Professor Liveing's suggestion on the arc spectrum of lithium when the arc was formed between carbon electrodes inserted horizontally in a magnesia brick. The arc enclosed in this way is much steadier than in the open. The light which was examined passed out through a horizontal hole perpendicular to the carbons. The differences described above between the spectra of the vapours near the two poles were easily observed by eye observations.

Photographs of the spark spectra of lithium were taken in the hope of finding a second line which would account for the remarkable differences in the arc spectra, but no second line was found. A piece of metallic lithium was placed in a cup formed in the end of an aluminium rod, and sparks were passed between this and an aluminium wire held immediately over the lithium. No Leyden-jar was put into the secondary circuit at first, and it was found that photographs of the blue line were obtained with exposures of fifteen minutes. The lines were sharp, and showed no signs of reversal. The wave-length of the blue line was found to be 4603·08. The vapour near the electrodes gave broader lines than the vapour a short distance away. The broadening was much greater at the negative electrode than the positive, and it extended further on the more refrangible side than on the other side. The bright line and the broad reversed line were, in fact, both present in the spectrum of the spark, near the negative electrode.

It was much more difficult to obtain photographs of the spark spectrum when a Leyden-jar was introduced. Some were obtained from moist lithium carbonate which had been fused into the aluminium cup. The blue line was very weak and nebulous, and it was difficult to obtain measurements of it. The following were obtained from four photographs:—4603·18, 4603·14, 4602·99, and 4603·97; the mean of these is 4603·15. Better photographs were obtained when a coil of wire was also introduced into the secondary circuit. The line more nearly resembled that obtained when no Leyden-jar was used; the broad reversed line was more clearly defined at the electrode when negative than when positive.

An attempt was made to photograph the blue line in the Bunsen flame spectrum, but with an exposure of six hours no trace of it was obtained.

Other Lines in the Spectrum of Lithium.

The orange line was examined in the arc and flame spectra by eye observations and by photography. The line in the flame spectrum was measured on four plates:—

Spectrum.	Wave-length.
244[3]	6103·84 centre of line.
244[5]	6103·85 near tip of line.
244[4]	6103·88 rather strong line.
245[5]	6103·84
245[8]	6103·83

The mean of these, omitting the rather strong line, is 6103·84. None of these lines showed any signs of reversal.

The wave-length of the bright line in the arc produced by the Gulcher lamp in the open was:—

Spectrum.	Wave-length.
241[6]	6103·81 nebulous in middle with sharp points. The nebulous part extended from 6102·46 to 6104·94.
242[4]	6103·86
242[5]	6103·82

The mean result is 6103·83

The orange line is easily reversed in the arc. The reversed line was photographed and the wave-length measured on two plates, the results being 6103·82 and 6103·84. The reversal was narrow and the wings did not extend very far. The more refrangible wing was slightly broader than the other, and this difference was observed in the photographs and by eye observations. The part of the arc near the negative pole was examined very carefully; the line was most sharply reversed in that part, but there was no trace of a broad dark line. The orange line, with the exceptions noted, behaved normally

Measurements were also made of the two other lines in the arc spectrum. The wave-length of a weak and very diffuse line on one plate was 4132·82, and that of a very weak sharp line 4273·32. The former line on another plate was stronger and broader; its middle was at 4132·35, whilst the other line, much broadened towards the red, had its strongest part at 4273·62.

The current used in working both the open and enclosed arcs was about 9 ampères. Kayser and Runge employed a current of 25—35 ampères from one machine, and, to bring out the weak lines in some spectra, a current of 40—50 ampères from another machine. It seems probable that they worked with the intense arc which was only obtained by the author when the carbons were very near together, and that they observed only the spectrum of broadened lines which the author found was emitted by the intense arc and near the negative pole by weaker arcs. Their remarks on the appearances of the lines in the first and second subordinate series confirm this view. Eder and Valenta obtained a similar spectrum to Kayser and Runge's arc spectrum in the spark spectrum of metallic lithium when they used a condenser in the secondary circuit.

The author has pleasure in thanking Professor Liveing for the interest he has taken in this work and for some useful suggestions.

Conclusions.

The lines in the principal series of lithium appear to broaden and reverse normally.

The lines in the second subordinate series do not reverse even in the arc, but in strong arcs they broaden towards the less refrangible end of the spectrum and become diffuse on that side.

The first line in the first subordinate series, wave-length 6103·84, is almost normal; it broadens slightly more on the more refrangible side than on the other. The other lines in this series also broaden on both sides and become diffuse, but they broaden more rapidly on the more refrangible side than on the other. The centres of the broadened lines are more refrangible than the corresponding lines in the narrow state. The inner core of intense arcs, and the parts near the negative poles of weak arcs and sparks, give a broad reversed line with its centre about wave-length 4602·4; whilst the part near the positive pole in weak arcs, and the flame of the arc, give a sharp bright line, wave-length 4603·07, coincident with the lines in the spectra of the oxyhydrogen flame and uncondensed spark. The similar changes in the other lines diminish with their refrangibility. The wave-lengths hitherto recorded for these diffuse lithium lines would appear to be those of abnormal lines. The true lines are the sharp bright ones which occur, without complication, in the spectrum of lithium in the oxyhydrogen flame.

(Added Nov. 28, 1902.—Since this paper was communicated to the Royal Society, I have seen a paper on the spectrum of lithium, by Hagenbach, in the *Annalen der Physik*, No. 12, 1902, which was published on November 13. His conclusion that there are two lines near wave-length 4603 is not, I think, established; and I still hold that the views expressed in this paper are more probable. He has not been able to find the second line as a bright line, so the difficulties in the way of accepting the view that there is a second dark line, without a corresponding bright line, remain. He has nor referred to Professors Liveing and Dewar's work (*Phil. Trans.*, 1883, vol. clxxiv., p. 215), and his evidence for saying there are two lines is, in fact, similar to the evidence they gave.)

Dichlorhydrate and Dibromhydrate of Cadinene.—Emilien Grimal.—The author succeeds in isolating the *d*-dichlorhydrate of *d*-cadinene, the *d*-dibromhydrate of *d*-cadinene, and a new *d*-cadinene, quite unknown before. —*Comptes Rendus*, cxxxv., No. 23.

NOTES ON THE ICELAND SPAR METHOD FOR THE STANDARDISATION OF HYDROCHLORIC ACID.

By W. HEBER GREEN, M.Sc.

In this method as proposed by Professor Masson (Chem. News, 1900, vol. lxxxi., p. 73), a dry beaker containing 2½—3½ grms. of Iceland spar is accurately weighed, and exactly 20 c.c. of the approximately normal hydrochloric acid are run in from a burette, the point of the burette and a watch-glass covering the beaker, being so arranged as to prevent loss from spirting.

After at least three or four hours, the covered beaker is raised to the boiling-point, and kept at or about that temperature for one hour. This drives off carbonic acid, and ensures the completion of the action.

The perfectly clear and neutral calcium chloride solution is now decanted off, and the beaker and residual spar (still in compact lumps) are thoroughly washed, dried at 110° C., cooled, and weighed.

The molecular weight of $CaCO_3$ being taken as 100·0 it follows that the difference between the original and final weighings (in grms.) will give without further calculation the "factor" of the hydrochloric acid.

For the last three years this method has been in constant use here in Melbourne, and it has been found that students inexperienced in quantitative work obtain results with this process involving errors of about 1 per cent in their first attempts, but hardly more than 1 in 1000 after they have had some practice.

Among the sources of error mentioned by Professor Masson the following seem to be of possible importance:—

1. The measurement of the acid.
2. Loss of weight of the beaker, due to solution of the glass during neutralisation.
3. The atomic weight of calcium is taken as 40·00, whereas the recent work by Hinrichsen gives 40·14. This introduces an uncertainty of over 1 in 1000.

The Measurement of the Acid.

With due attention to temperature and burette calibration and cleanliness, the accuracy obtained should be at least as great as in any volumetric work.

The use of a standard pipette instead of a burette was suggested as being possibly more accurate.

A number of experiments showed that when cleansed from grease by alkali the average divergence from the mean amounted to about 0·03 c.c. with a 20 c.c. pipette, but if allowed to become greasy again by several days' use or even exposure to the air without re-cleansing, discrepancies of 0·015 c.c. may be expected. With a carefully cleansed burette (an alcoholic solution of soap is recommended for this purpose) volumes agreeing to within 0·01 c.c. may be measured.

Loss of Weight of the Beaker.

The researches of Pfeiffer, Mylius, and Foerster, Weber and Sauer, and Kohlrausch (*vide Ber.*, 1892, xxv.) show that glass, consisting as it does mainly of sodium or potassium and calcium silicates, when acted on by water, loses some of its alkali, which (if not neutralised by the presence of acid) exerts its own influence in dissolving silica as well.

Consequently, acids dissolve less than pure water, whilst alkalis attack the glass as a whole, and in this respect are similar to hot and especially superheated water, which is also a solvent for silica itself.

The action of salts depends on the concentration and on the reactions which take place between them and the substances extracted from the glass.

Hot water dissolves glass much more rapidly than cold water, and considerably diminishes its solubility in the latter (Pfeiffer, *Ann. Phys. Chem.*, [2], xliv., 239),

TABLE I.

No.	Description.	Weight.	Total area of surface.	Previous loss.	Loss when boiled in 4E-HCl for two hours.	Total loss per sq. decimetre.
		Grms.	Sq. c.m.	M.grms.	M.grms.	M.grms.
I.	7-oz. Bohemian glass beakers	24·6	330	3·8	2·9	2·03
II.		27·7	330	4·8	1·8	2·00
III.	5-oz. Bohemian glass beakers	19·8	220	Unused	2·6	1·18
IV.		15·8	220	Unused	2·55	1·16

TABLE II.

	Description of vessels.	Weight.	Total area of surface.	Loss on boiling for two hours in 4E-HCl.	Loss during first standardisation.	Loss on boiling for two hours in 2E-$CaCl_2$ and two hours in water.	Loss after one week in water at 25° C.	Loss during second standardisation.	Total loss per square decimetre.
		Grms.	Sq. cm.	M.grms.	M.grms.	M.grms.	M.grms.	M.grms.	M.grms.
V.	5-oz. Bohemian glass beakers	18·2	220	7·4	0·65	1·85	0·0	0·55	4·75
VI.		20·8	220	4·25 (*a*)	0·45	2·05	0·05	0·3	3·25 (*a*)
VII.	5-oz. conical parting flasks	32·7	290	(6·4 ?)	1·55	2·45	—	—	3·58
VIII.		32·4	290	6·35	1·4	(2·4 ?)	0·0	—	3·50
IX.	50 c.c. Jena glass flasks	23·0	240	0·85	0·35	−0·1	—	0·1	0·55
X.		19·8	240	0·9	0·45	+0·05	—	0·1	0·65

(*a*) Beaker VI. had been previously used for analytical work.

The best glass for chemical purposes has a composition approximating to the formula—

$$3(K_2O(\text{or } Na_2O).3SiO_2).2(CaO.3SiO_2).$$

In the Iceland spar method the glass beaker is exposed to the action of a cold acid solution of calcium chloride for a period which may vary from three or four hours to over twenty hours, and to a boiling solution of calcium chloride, which rapidly becomes neutral, for one hour.

Any alkali dissolved out of the glass in the cold, or before all the hydrochloric acid has been neutralised, will cause some of this acid to be converted into sodium or potassium chloride instead of dissolving its equivalent quantity of spar. Any solution of the glass after that time, however, will not affect the amount of spar dissolved, but will necessitate the taring of the empty beaker before and after the experiment.

The total amount dissolved has hitherto been assumed to be negligible, but discordant results obtained by students in the University laboratory, especially when new beakers have been used, have given rise to the suspicion that an appreciable error may be so introduced.

One student was asked to weigh the beakers (previously unused) before and after each experiment.

The losses he observed were :—

	Beaker I.	Beaker II.
	M.grms.	M.grms.
During first standardisation ..	2·1	2·5
During second standardisation ..	1·3	1·2
During third standardisation ..	0·4	1·1
Total loss of weight	3·8	4·8

But his results were not concordant enough to indicate how much, if any, of the hydrochloric acid had been neutralised by the alkali dissolved from the glass. Taking advantage of the necessity which arose (in connection with other research work) of standardising with accuracy an approximately normal hydrochloric acid solution, it was decided to investigate this source of error more thoroughly.

The two beakers above mentioned and two new ones (for comparison) were placed in a large beaker together, and were covered with 4E-HCl (*vide* Reddrop's system, CHEMICAL NEWS, 1890, vol. lxi.), which was kept at the boil for two hours. (See Table I.).

Evidently the previous loss of I. and II. has only diminished their solubility, neither can III. and IV. be considered as having been rendered completely insoluble, but it seems probable that little further loss would take place in a calc-spar experiment before all the acid had been neutralised, and, consequently, the loss in weight of the glass, if any, subtracted from the apparent loss of spar should give the true strength of acid.

As this make of beakers (recently imported from an English firm) showed a tendency to devitrify if overheated in the air-bath, they were discarded and other vessels employed.

After weighing, the six beakers and flasks used were rinsed in hot dilute alkali to cleanse them from grease, and were then boiled in 4E-HCl for about two hours; they were washed with distilled water, dried, and weighed.

In each beaker or flask were placed 2—3 grms. of Iceland spar (in two or three lumps which had been previously treated with dilute acid to round the corners), and the vessels were re-weighed.

The standard acid was measured with a 20 c.c. pipette; the temperature being noted. The importance of this precaution does not seem to be sufficiently recognised. (An alteration of 4° C. will affect the normality to the extent of 1 in 1000).

The beakers were covered with suitable watch-glasses, which were moved slightly to one side to allow the point of the pipette to be introduced; in the case of the flasks the acid was run through a small funnel placed in the neck to avoid loss by spirting of the acid, and the funnel was then rinsed with water.

The vessels were left to stand over night, and next day raised to the boiling-point on a clean asbestos card, and kept at—or about—that temperature for one and a half to two hours. This time was unnecessarily long, one hour at the boiling-point sufficing to neutralise any acid that may remain after standing over twelve hours in the cold, and to remove dissolved carbonic acid. Neutralisation may be taken as complete when bubbles of carbonic acid are no longer given off, and the liquid shows a tendency to bump.

The calcium chloride solution was decanted off, and kept, in each case with its own washings, in separate vessels.

The beakers and residual spar were dried, cooled, and weighed as described in Professor Masson's paper. Finally, the spar was emptied out, and the vessels themselves re-weighed. (See Table II.).

In order to test the effect of calcium chloride on the glass, 25 c.c. of 2E-$CaCl_2$ (neutral to litmus) was placed in each vessel and boiled for two hours, and then the solution was rinsed out and replaced by a similar amount of water which was also boiled for two hours. In the case of the Jena flasks, the calcium chloride solution was accidentally boiled down to 4 or 5 c.c., and some difficulty was found in washing the flask out, possibly accounting for the slight gain observed in IX.

Beakers V. and VI. and Flask VIII. were immersed in

a water-bath kept at 25° C. for a week, and in only one case was any loss perceptible on a balance capable of weighing accurately to 0·05 m.grm.

This confirms Pfeiffer's conclusion that treatment with hot water protects the glass from further action of water at a lower temperature.

Attention is directed to the behaviour of the Bohemian glass beakers and the Jena glass flasks when employed in a second standardisation after the experiments described above.

The Jena glass is seen to be far superior, and I would suggest that *for the Iceland spar method, conical Jena glass flasks (Erlenmeyer pattern) be employed after having been boiled for* three to four *hours with acidulated water*, a treatment which should be applied to all pycnometers, Sprengel tubes, and other glass vessels which are supposed to remain constant in weight although exposed to the action of water or aqueous solutions.

The results given in Table III. clearly justify the assumption that the glass vessels employed in the standardisation, when treated as directed, did not appreciably lose weight until all the acid had been neutralised; for the maximum variation from the mean value (0·99803), found as the normality of the acid, is not more than 0·00013—a quantity within the error of the pipette measurement.

The Molecular Weight of the Iceland Spar Employed.

This may be readily determined, and at the same time an accurate check on the method obtained, by precipitating as AgCl the chlorine in the calcium chloride solution obtained in each experiment.

The directions given by Fresenius for the precipitation of chlorides by slight excess of silver nitrate in presence of nitric acid were followed closely, the filter-paper being burnt separately and the bulk of the precipitate then added, and finally heated to fusion at the edges, after treatment with HNO_3 and HCl, though it had as far as possible been kept in a dark room, and showed merely the slightest signs of darkening.

Comey ("Dictionary of Solubilities") states that silver chloride is slightly soluble in sodium and calcium nitrates. No data are given for calcium nitrate, but a solution of sodium nitrate of about the strength employed will dissolve 20—25 mgms. of silver chloride per litre.

As calcium chloride has very nearly the same capacity as sodium chloride for dissolving AgCl, I have, in the absence of any exact data, felt justified in assuming the solubility of freshly precipitated AgCl to be 24 m.grms. per litre of filtrate. In pure water the solubility is given as 1·8—2·0 m.grms. per litre at ordinary temperatures.

The volumes of the filtrates and washings were noted and corrections applied on the above basis, but in view of the uncertainty involved, the uncorrected values are given for comparison.

In calculating the molecular weight of the Iceland spar the accuracy of the method and the purity of the reagents have been assumed, and the correction for the solubility of AgCl has been introduced. (Taking Ag = 107·93, Cl = 35·45, and $CaCO_3$ = 100·00, then 2·8676 grms. of AgCl should be obtained for each grm. of $CaCO_3$ dissolved). (See Table III.).

In considering these results it must be borne in mind that the determination of the atomic weight of calcium was not the object of these experiments, and that only analytical precautions were taken, the following sources of error not being accounted for:—

1. Ordinary clear fragments of Iceland spar were employed, and any impurities they may have contained were not determined. (The Iceland spar used by Erdmann and Marchand, in determining the atomic weight of calcium, contained 0·04 per cent impurities.)

2. The silver nitrate and hydrochloric acid employed were "pure" reagents and were not specially purified.

3. The solubility of silver chloride in calcium nitrate solutions was not investigated, and only approximately corrected for.

TABLE III.

Vessels employed.		Total loss of glass and spar.	Loss in weight of glass. M.grms.	Iceland spar dissolved.	Strength of HCl from each pair of vessels.	Weight of AgCl. Uncorrected.	Weight of AgCl. Corrected for solubility.	Strength of HCl calculated from AgCl. Uncorrected.	Strength of HCl calculated from AgCl. Corrected for solubility.	Weight of AgCl per grm. of spar dissolved. Uncorrected.	Weight of AgCl per grm. of spar dissolved. Corrected for solubility.	Molecular weight of Iceland spar.
V.	Bohemian glass beakers ..	0·9988	0·65	0·99815	0·998075	2·8572	2·8608	0·99643	0·99770	2·8625	2·8661	100·053
VI.		0·99845	0·45	0·9980		2·85755	2·86115			2·8633	2·8669	100·025
VII.	Conical parting flasks ..	0·9995	1·4	0·9981	0·9980	2·8584	2·8618	0·99664	0·99783	2·8638	2·8672	100·014
VIII.		0·99945	1·55	0·9979		2·8576	2·8610			2·8636	2·8670	100·021
IX.	Jena glass flasks . ..	0·99845	0·35	0·9981	0·998025	2·85915 (a)	2·86225	0·99680	0·99787	2·8646	2·8677 (a)	
X.		0·9984	0·45	0·9979		2·8581	2·8612			2·8640	2·8671	100·017
					0·99803			0·99662	0·99780	2·8635	2·8669	100·02

(a) The AgCl in IX. was known to be slightly too high, owing to the presence of a fragment of unburnt filter-paper; consequently this result was not used in calculating the average values.

4. The weighings were not reduced to vacuum. The corrections, if applied, would amount on the spar to 0·3 m.grm. per grm., and on the silver chloride to 0·1 m.grm. per grm.; but it must be observed that variations in the atmospheric conditions could easily be sufficient to cause differences in the apparent weight of the beakers of over 0·1 m.grm.

5. The weights were not corrected, and errors amounting to tenths of m.grms. were known to exist.

6. Glass vessels which lost weight during the experiment were employed, and though this loss was determined so as to obtain the true loss of weight of the spar, a minute error is still possible if any portion of the acid were neutralised by the alkali of the glass.

The results obtained may, however, be held to prove that for the purposes of standardising hydrochloric acid solutions (and also for obtaining a standard solution of neutral calcium chloride) in the laboratory, the molecular weight of Iceland spar may be taken as 100·0, and that the accuracy of the measurement of the acid will, in practice, determine the accuracy of the standardisation.

For extreme accuracy the precautions indicated as to the use of Jena flasks previously extracted by boiling in acidulated water must be attended to.

Without question, the method is preferable to any other in common use.

The University of Melbourne, October 1, 1902.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month Ending November 30th, 1902.

By SIR WILLIAM CROOKES, F.R.S.,
and
PROFESSOR DEWAR, F.R.S.

To Charles Perrin, Esq., M.Inst.C.E.,
Water Examiner, Metropolis Water Act, 1871.

London, December 10th, 1902.

Sir,—We submit herewith, at the request of the Directors, the results of our analyses of the 206 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from Nov. 1st to Nov. 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in previous reports.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 206 samples examined by us chemically during the month, all were clear, bright, and well filtered.

The rainfall at Oxford has been again below the average; the rainfall actually measured during November is 2·24 inches, the average is 2·30 inches; this leaves a deficit of 0·06 inch, and when added to the previous one of 7·84 inches, makes a total deficit of 7·90 inches, or 34·1 per cent on the thirty-five years' average.

Our bacteriological examinations of 508 samples have given the results recorded in the following table; besides these we have examined 109 other samples, from special standpipes, wells, &c., making a total of 617 samples in all:—

	Microbes per c.c.
New River, unfiltered (mean of 24 samples) ..	277
New River, filtered (mean of 123 samples) ..	16
Thames, unfiltered (mean of 25 samples) ..	2262
Thames-derived water, from the clear-water wells of eight Thames-derived supplies (mean of 279 samples)	35
Ditto ditto .. .. highest	452
Ditto ditto .. .. lowest	0
River Lea, unfiltered (mean of 25 samples) ..	253
River Lea, from the East London Company's clear-water wells (mean of 32 samples) ..	13

Of the 434 daily samples taken from the filter-wells of the Metropolitan Water Companies, and examined bacteriologically by us, eleven samples, or 2·5 per cent, were sterile. Fourteen samples contained more than 150 microbes, while twenty-seven samples, or 6·2 per cent, contained more than 100 microbes per c.c. The mean number of microbes in the twenty-seven excess samples was 165, against a corresponding mean of 145 in twelve excess samples in October.

The small increase in the number of microbes during November is no doubt due to the larger rainfall. Past experience has shown that, but for the exceptional season, we should have anticipated that the supplies ere this time would have exhibited a more marked increase in vegetable organic matter and harmless microbes. The quality of the water supply is excellent, and is better than the average of the usual winter standard.

We are, Sir,
Your obedient Servants,
William Crookes.
James Dewar.

THE USE OF ACID NITRATE OF MERCURY IN THE ANALYSIS OF SUGAR LIQUORS.

By G. PATEIN and E. DUFAU.

The analysis of sugar liquors offers a certain number of difficulties, among which is the elimination of impurities which accompany the sugar under examination, especially when these substances have a rotatory power, or when they reduce Fehling's solution and decolourise or modify the colour of that reagent. The treatment of the liquor to be analysed by subacetate of lead has long been recommended, followed by the precipitation of the excess of lead by sulphate or carbonate of soda; but, since it has been seen that this process might bring about a loss of sugar, recourse has been had to the neutral acetate of lead, and Courtonne's solution has come into general use. This latter reagent, as has been shown by us, though excellent in most cases, is itself incapable of precipitating certain nitrated compounds which are often met with in the liquors, and which can only be removed by the acid nitrate of mercury.

But though the mercurial salt was well received it was not accepted universally, and MM. Lépine and Boulod condemned it in a sentence we came across in several journals (*Review de Médecine*, 1901, p. 633; *Lyon Medical*, 16 June, &c.)* in which they published their work, as well as in the *Bulletin des Sciences Pharmacologiques*, 1901, p. 399.

It has been known for a long time that the mercuric salts are able to oxidise sugars, and the methods of estimation of Knapp, Pillitz, and Sacchsse are well known, but to effect this both heat and the presence of alkalis are necessary; time and direct sunlight act in the same

* M. Patein has proposed to treat urine with acid nitrate of mercury, before polarimetric examination; but it has been found by one of us (M. Boulod) in a special series of tests, that the use of the acid nitrate of mercury is to be condemned entirely; this salt destroys a portion of the sugar.

manner. Again, we have distinctly specified that it is necessary to add only the amount of soda that is actually necessary to effect neutralisation. Furthermore, it will be seen in what follows how sugars dissolved in water really behave in the presence of mercuric nitrate. For these experiments we have used nothing but chemically pure products.

Primarily we have observed that if we make a very dilute solution of *glucose*, say 0·2 grm. per litre, by using the acid nitrate with the given precautions, we can detect the presence of sugar with the aid of Fehling's solution as distinctly as in a solution not treated with the mercurial reagent; thus, the use of this latter is perfectly well justified for very dilute solutions of sugar. If, on the other hand, the sugar is oxidised, we ought to find a corresponding quantity of the mercurial salt reduced. To try and find if this is the case, we carried out the following experiments on different sugars:—1 grm. of sugar was dissolved in 50 c.c. of water; 10 c.c. of the solution of mercuric nitrate was added, of which we give the formula further on; then soda drop by drop until the acid reaction has disappeared; filter, and after filtration it was found that the filtrate which remained perfectly limpid did not give any precipitate with hydrochloric acid—therefore it did not contain any mercurous salt; as for the precipitate remaining on the filter, this was collected and dissolved in dilute hydrochloric acid; the solution was not quite complete, but the residue, which consisted of mercurous chloride, was very slight; when collected, washed and dried, its weight varied from 2 to 5 grms. A check solution, not containing any sugar, and treated in the same manner as the other one, also gave a residue of mercurous chloride weighing 2 grms. Thus, we are justified in stating that the oxidising action of the acid nitrate of mercury on reducing sugars does not show itself to any noticeable extent, if our instructions are followed.

	Solution in pure water.	Solution treated with mercuric nitrate.	Solution treated with peptone and then with nitrate.	Solution treated with nitrate and then with hypophosphite.
Saccharose—				
Polarimetry	11·4°	11·3°	11·3°	hydrolysed
	8·6°	8·6°	8·5°	—
Fehling ..	—	—	—	—
Lactose—				
Polarimetry	11·5°	11·5°	11·5°	11·5°
	9·4°	9·3°	9·3°	9·3°
Fehling ..	11·8 c.c.	—	—	12·0 c.c.
	7·8 c.c.	—	—	7·9 c.c.
Maltose—				
Polarimetry	9·5°	9·4°	—	9·4°
	9·4°	9·3°	—	9·3°
	4·8°	4·7°	—	4·7°
Fehling ..	17·8 c.c.	—	—	18·2 c.c.
	9·6 c.c.	—	—	9·8 c.c.
Glucose—				
Polarimetry	8·4°	8·3°	8·3°	8·3°
	8·8°	8·7°	8·7°	—
	4·1	4·1°	4·1°	—
Fehling ..	9·0 c.c.	—	—	9·1 c.c.
	6·1 c.c.	—	—	6·2 c.c.
Lævulose—				
Polarimetry	−7·5°	−7·5°	—	−7·5°
	−6·4°	−6·3°	—	−6·3°
Fehling ..	10·3 c.c.	—	—	10·4 c.c.
	8·8 c.c.	—	—	8·9 c.c.
Arabinose—				
Polarimetry	7·5°	7·5°	—	—
	7·5°	7·4°	—	7·4°
Fehling ..	11·3 c.c.	—	—	11·4 c.c.
	11·4 c.c.	—	—	11·6 c.c.

We have also verified the fact that, even if it is not neutralised, nitrate of mercury does not invert the hydrolysable sugars, and does not modify the rotatory power of any of the sugars with which we have had to deal.

That being settled, we will give the most complete details of the method of working we have employed.

1. *Preparation of the Mercuric Reagent.*—The formula we originally gave may be adhered to and the ordinary acid nitrate used; however, among other impurities, this salt generally contains a little mercurous nitrate, and, to obtain a solution free from this body we prefer to proceed in the following manner:—

We take 220 grms. of the yellow oxide of mercury and treat it with 200—300 c.c. of water, and the exact quantity of nitric acid necessary to effect its solution; a few drops of soda-lye are added until a yellowish precipitate just appears, the volume is made up to a litre and the solution filtered. This solution does not contain any excess of nitric acid, and the amount of mercurous salt present is negligible.

2. *Soda Solution.*—Soapmaker's lye is used, treated with four times its volume of water; the liquid is left in a glass vessel, and the carbonic acid of the air does not interfere with it in any way.

3. *Method of Working.*—We will describe, as an example, one of our estimations of glucose. We took a solution containing 4·50 grms. of pure anhydrous glucose in 100 c.c. of water. We measured off successively 20 c.c. into two test-glasses graduated to 50 c.c.; in one of them this volume was made up with water, and to the other we added 10 c.c. of the mercuric reagent and 10 c.c. of water; after well stirring, and by means of a burette, the soda solution was added drop by drop, with continual stirring with a glass rod, taking care to stop for a while after each five or six drops, to allow the precipitate to settle; if the soda-lye is not carbonated, this precipitate will be first white, then yellowish, and gradually become darker; if, on the other hand, it is strongly carbonated, the precipitate is much more brown in colour. But however it may be, we continue to add the sodic liquor until one drop of the clear solution does not turn blue litmus-paper red; the volume is then made up to 55 c.c. with distilled water, shake well, and filter. If the operation has been carried out properly, the solution is neutral or at least barely alkaline; it is, and remains, perfectly limpid; it is not precipitated by hydrochloric acid nor by the addition of a drop of the sodic solution. As for the precipitated mercuric oxide, it ought to dissolve almost integrally in dilute hydrochloric acid; the insoluble residue of mercurous chloride was 3 c.grms. On examining our two solutions in the saccharimeter we found 8·7° or 17·72 grms. of glucose per litre for the one simply diluted with water, and, for the one treated with mercuric nitrate, 8·6°, or 17·71 grms. of glucose per litre; the actual amount taken was 18 grms. per litre.

4. *Volumetric Estimation.*—If we wish to estimate the glucose by means of Fehling's solution in the above solution, treated with mercuric nitrate, we obtain too low a result. Does this come from any destruction of sugar? Not at all; it arises from the fact that the sugar liquor always retains some of the mercuric salt in solution, and when we pour in the boiling Fehling's solution the sugar is oxidised both by the latter and by the mercuric salt, as is proved by the black colour taken by the cuprous oxide. It is necessary, therefore, to commence by eliminating the mercury, and this precaution is equally indispensable in the processes in which the oxide of copper is weighed or the copper reduced, and in which a salt of mercury has been used to purify the sugar. It is on account of the constant presence of mercury in solution that we have recommended, for the polarimetric examination, the use of tubes lined with glass, or else the precipitation of the mercury by hypophosphite of soda according to Maquenne's method. Hypophosphite of soda in boiling alkaline solution, partly decolourising the Fehling's solution, does not seem suitable for use in volumetric estimations. However, we obtained the most satisfactory results in the following manner:—To 50 c.c. of the sugar

liquor treated with mercuric nitrate, we add two drops of hydrochloric acid, then 8 c.grms. of hypoposphite of soda, and heat for a moment to 60—70°, the solution first becomes cloudy, then a precipitate is formed which agglomerates or becomes granular, floating in the clear liquid; after cooling this is filtered; the filtrate is absolutely free from mercury, and does not contain more than a few milligrms. of hypophosphite, which have no influence on the estimation. The action of heat is sufficiently slight and of short duration not to change the volume of the solution or to effect any hydrolysis of the sugars, except with saccharoses.

To make the estimation with Fehling's solution, the solution is neutralised and diluted so as to contain about 5 grms. of sugar per litre. In this manner we have found with the experimental solution, that to decolourise 10 c.c. of Fehling's solution it required, after dilution, 7·7 c.c. of simple glucose and 7·9 c.c. of the solution treated with mercuric nitrate.

The accompanying table shows the results we have obtained with different sugars; our experiments have been far more numerous than those we describe here.

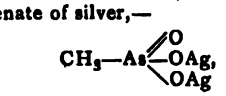
We see that the variations caused by the acid nitrate of mercury are not great; glucose appears to be the most sensitive sugar, and the neutralisation with soda ought to be done with the greatest care; levulose, maltose, and lactose are much less sensitive. This method of treating sugar liquors, therefore, is not to be passed over; in a future paper we shall show that in certain cases it is even necessary.—*Journ. de Pharm. et Chim.*, Series 6, vol. xv., No. 5.

VOLUMETRIC ESTIMATION OF DISODIC METHYLARSENATE.

By ELIE FALIÈRES.

I HAVE determined the conditions under which methylarsenate of silver ought to be used for the estimation of the new salt described by Prof. Armand Gautier. I have been enabled thus to devise a method for the volumetric titration of disodic methylarsenate, of which the accuracy is absolutely equal to that of an estimation of alkaline chlorides, with which it is connected.

Methylarsenate of silver,—



is almost insoluble in water, but though slight its solubility is sufficient to interfere with the correctness of the estimation of the silver salt when washed and dried, in comparison with a sample of disodic methylarsenate.

The wash-waters from the methylarsenate of silver are, in fact, indefinitely and distinctly precipitable by hydrochloric acid or chlorides. It is impossible to know when to stop washing the precipitated methylarsenate of silver. The results are always too low and vary according to the duration and amount of the washing.

But though the methylarsenate is not insoluble in water, it is, on the other hand, completely insoluble in a solution of N/10 or even N/20 nitrate of silver. In this case its insolubility is as absolute as that of sulphate of barium of chloride of silver.

I have proved this insolubility experimentally by leaving a demi-decinormal solution of nitrate of silver for several hours in contact with precipitated, thoroughly well-washed and well-drained methylarsenate of silver. The silver solution has not dissolved the least trace of the methylarsenate; its titrated strength, after filtration, remained exactly the same, viz., demi-decinormal.

The same is the case with decinormal nitrate of silver.

Pure disodic methylarsenate crystallises regularly with 6 molecules of water, which it loses completely at a temperature of 120—130°, and which it takes up again to a very great extent by simple exposure to the air.

The rapidity with which the anhydrous salt becomes hydrated, no doubt accounts for the differences in the number of molecules of water of crystallisation which have been variously attributed to this salt when crystallised; 143 m.grms. of anhydrous disodic methylarsenate weighed rapidly on taking from the oven, gained 20 m.grms. of water in five minutes; 32 m.grms. in twenty minutes; 41 m.grms. in forty minutes; and 45 m.grms. in forty-five minutes. These figures show that unless we take precautions in weighing, altogether beyond the precautions usually necessary, it is of no use to take the anhydrous or supposed anhydrous salt in making an estimation. It is preferable to take the salt $As(CH_3)O_3Na_2,6H_2O$, of which the composition remains constant even after being exposed to the air for several days. The atomic weight of the anhydrous salt is 184, that of the crystalline salt 292. The normal crystalline salt contains 37 per cent of water and 25·68 per cent of arsenic.

We must first make sure that the methylarsenate to be determined does not contain any of the following salts:—Chlorides, sulphates, arsenites, arsenates, phosphates, carbonates, or iodides.

0·2 grm. of the crystalline salt is weighed out and dissolved in exactly 10 c.c. of water. 40 c.c. of a decinormal solution of neutral nitrate of silver are added, thus:—

$$0{\cdot}017 \text{ grm.} \times 40 = 0{\cdot}68 \text{ grm. } NO_3Ag.$$

After stirring thoroughly it is filtered rapidly. The filtrate, having a total volume of 50 c.c., including the portion absorbed by the filter-paper and the precipitate itself, contains the whole of the nitrate of silver, which has not been used for the precipitation of the methylarsenate of silver.

We then determine how many cubic centimetres of this filtrate must be used to obtain the tint of chromate of silver with 10 c.c. of N/10 chloride of sodium diluted with 30 c.c. of distilled water.

Ten c.c. of N/10 chloride of sodium correspond to 0·17 grm. of nitrate of silver, so by a simple calculation we find the weight A of the nitrate of silver still remaining in the 50 c.c. of the liquid under examination. This weight A subtracted from 0·68 grm. gives the weight N of the nitrate of silver precipitated in the form of methylarsenate of silver.

By applying the formula $\frac{292 \times N \times 5 \times 100}{340}$ we get the value in hundredths of the disodic methylarsenate in question; 292 = a molecule of disodic methylarsenate, 340 = a double molecule of nitrate of silver, 5 = multiplying the amount taken by 0·2 grm.

The results are extremely accurate, and absolutely concordant on several estimations of the same sample.

Analytical Results.

Pure Salt in the Laboratory.—N = 0·232, from which we get $\frac{292 \times 0{\cdot}232 \times 5 \times 100}{340} = 99{\cdot}91$ per cent.

Salts from various Sources.—(A). N = 0·226—

$$\frac{292 \times 0{\cdot}226 \times 5 \times 100}{340} = 97{\cdot}01 \text{ per cent.}$$

(B). N = 0·223—

$$\frac{292 \times 0{\cdot}223 \times 5 \times 100}{340} = 95{\cdot}93 \text{ per cent.}$$

(C). N = 0·231—

$$\frac{292 \times 0{\cdot}231 \times 5 \times 100}{340} = 99{\cdot}17 \text{ per cent.}$$

—*Journ. de Pharm. et Chim.*, Series 6, vol. xv., No. 10.

NOTICES OF BOOKS.

Notions Fondamentales de Chimie Organique ("Fundamental Notions of Organic Chemistry"). By Ch. Moureu. Paris: Gauthier-Villars. 1902.

This is a text-book dealing with the general theory of organic chemistry, all questions of detail and the study of individual substances being designedly omitted. If extensive practical work in organic chemistry is done, the student undoubtedly learns more satisfactorily the details of the subject by studying the preparation and properties of the more common substances in the laboratory by practical methods, and acquires a more comprehensive view of the whole subject by reading in his text-book only of groups of bodies of the same type. This ideal method unfortunately has often to be very considerably modified in order to save time. This book will be found in many ways most useful, the general plan being on the whole excellent. We should not advise its use, however, as suggested in the preface, as an introduction to a complete course or treatise, but in conjunction with some good practical book and constant laboratory work. The contents are divided into six chapters, the first being introductory and discussing general theories of isomerism and stereo-chemistry; the student then takes up the hydrocarbons and compounds containing oxygen and nitrogen, thence proceeding to organo-metallic and heterocyclic bodies. The chapter on nitrogen compounds is specially well written, but the methods of preparing hydrocarbons might have been made more complete with advantage.

Die Chemische Technologie der Brennstoffe ("The Chemical Technology of Fuels"). By Dr. Ferdinand Fischer. Braunschweig: Friedrich Viewig und Sohn. 1901.

This volume of the hand-book of chemical technology now in course of publication deals with the chemistry of all classes of fuels; the author has endeavoured to produce a clear and comprehensive exposition of his subject. The volume is copiously illustrated throughout, and the illustrations are in many cases very elaborate in detail; in places the text requires substantial additions to bring it up to date. Though the practical side of the subject is most emphasised, the scientific side is not by any means neglected; the chapters on producer-gas and water-gas are among the best in the book.

Wellenlängen-Tabellen für Spektralanalytische Untersuchungen auf Grund der Ultra-violetten Funken Spektren der Elemente ("Wave-length Tables for Spectral Analysis on the basis of the Ultra-violet Spark Spectra of the Elements"). By Professor Franz Exner and Dr. E. Haschek. Leipzig und Wien: Franz Deuticke. 1902.

This collection of tables of wave-lengths for spectral analysis will undoubtedly supply a want. The compilers have made the determinations with the greatest possible accuracy, using the same method throughout. The elements examined include all at present known with the exception of terbium and of the rare gases argon, helium, &c. The tables are three in number, and fill two volumes; the first gives the principal lines of the elements arranged alphabetically under their symbols, and will be found useful in showing rapidly whether a given element is present in an unknown spectrum. The second table gives all the lines arranged in ascending order of wave-length of all the elements, and thus provides a means of identifying unknown lines. The third table, which fills the whole of the second volume, gives the complete spark spectra of all the elements, each element being prefaced by a few notes explaining whether the electrodes consisted of the element itself, or of carbon saturated with a solution of a compound, and also giving the most probable impurities present. The compilers hope to prepare shortly similar tables of the arc spectra of all the elements.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxv., No. 23, December 8, 1902.

Transformation of the Diamond into Black Carbon during its Oxidation, and the Isomeric Changes of Simple Bodies during Decompositions and Combinations.—M. Berthelot.—During a series of experiments made some years ago to determine the heat of combustion of carbon in different states, and especially that of the diamond, the author burnt diamonds incompletely in pure dry oxygen in crucibles placed in porcelain or hard glass tubes. The amount of amorphous carbon produced by this method was always very small, too small in fact to allow of a study of its isomeric state. However, it seemed probable that from his experiments that it contained some graphite.

The Quantity of Pure Hydrogen in the Air and the Density of Atmospheric Nitrogen.—Armand Gautier.—The presence of free hydrogen in the atmosphere is important from the point of view of the origin of the air, its constitution, the constitution of the upper layers of the atmosphere, and the part which this gas takes in meteoric and chemical phenomena. It is certain that the composition of the air is slightly variable, and the weight of unit volume is not the same in the country, in populous towns, over the sea, and in the higher regions of the atmosphere.

Bipolar Electrodes with Soluble Anode.—André Brochet and C. L. Barillet.—The authors' researches on bipolar electrodes lead them to the following conclusions:—(1) Bipolar electrodes with soluble anode change the flow of the current because of important phenomena of polarisation. (2) A useful application of bipolar electrodes necessitates that they form water-tight partitions; the spaces reserved for the circulation of the liquid should be as small as possible to avoid the loss, which is considerable with soluble anodes. (3) If the apparatus necessitates a violent agitation to make the electrolyte circulate transversely between the electrodes in all compartments at a time, the electrodes should be introduced into frames of large dimensions. (4) In an electrolyser it is best to use metallic strips not communicating with the electrodes.

Thallic Chloride.—V. Thomas.—In a previous paper the author described in a general manner the halogen compounds of thallium of the type ThX_3. Amongst others he shows the easy formation of the compounds corresponding to the formulæ—$ThCl_3.4H_2O$, $ThCl_2Br.4H_2O$, $ThClBr_2.4H_2O$, and $ThBr_3.4H_2O$. These compounds are all characterised by the ease with which they combine with one molecule of hydracid. If the two extreme members of the series represent well-defined chemical substances, the intermediate members must be looked upon as mixtures of chlorides and bromides—

$$3ThCl_2Br.4H_2O = 2ThCl_3.4H_2O + ThBr_3.4H_2O,$$
$$3ThClBr_2.4H_2O = 2ThBr_3.4H_2O + ThCl_3.4H_2O.$$

The author now makes a study of the trichloride, $ThCl_3.4H_2O$, and finds (1) that anhydrous thallium trichloride is capable of existence, and (2) that thallic chlorobromides do exist, from the fact that in a vacuum they lose both chlorine and bromine.

The Violet Manganic Metaphosphate of Gmelin.—Ph. Barbier.—M. Laspeyre, repeating Gmelin's researches, obtained a dark violet syrupy mass soluble in water, giving a ruby-red colouration. The solution becomes decolourised as it is heated, an insoluble greenish-grey powder being deposited. The author repeats this experiment, and makes a further examination of the product.

MEETINGS FOR THE WEEK.

SATURDAY, Jan. 3rd, TUESDAY, 6th. THURSDAY, 8th. } Royal Institution, 3. (Christmas Lectures, adapted for Young People). "On Locomotion—on the Earth, through the Water, in the Air," by Prof. H. S. Hele-Shaw, LL.D., F.R.S., M.Inst.C.E.

MONDAY, 5th.—Society of Chemical Industry, 8. "Fluorescence of Naphthalic Anhydride," by Dr. J. T. Hewitt. "Saponification of Fats and Oils by means of Dilute Acids," by Dr. J. Lewkowitsch

WEDNESDAY, 7th.—Society of Arts. 5. (Juvenile Lecture). "Means of Defence in the Struggle for Life among Animals," by Prof. E. B. Poulton, F.R.S.

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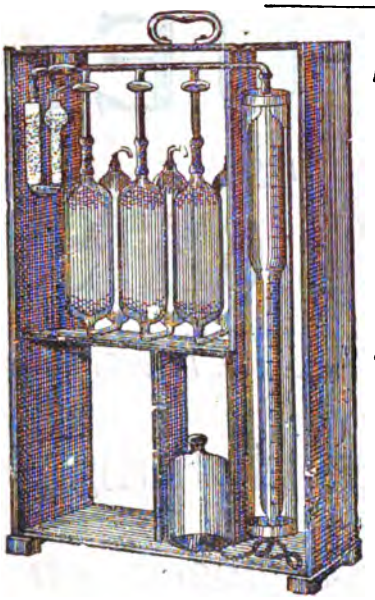

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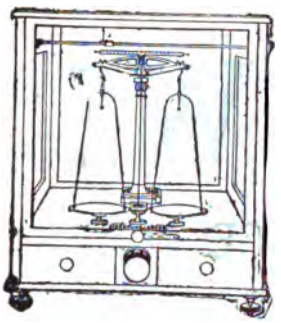

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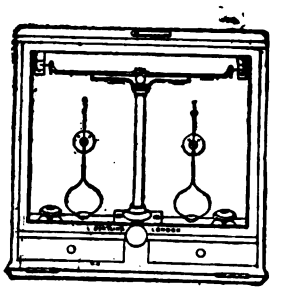

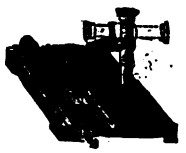

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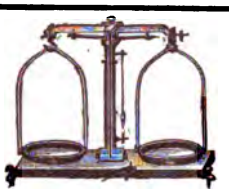

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THE CHEMICAL NEWS.

VOL. LXXXVII., No. 2250.

ISOMERIC CHANGE IN BENZENE DERIVATIVES.*

THE INTERCHANGE OF HALOGEN AND HYDROXYL IN BENZENEDIAZONIUM HYDROXIDES.

By K. J. P. ORTON, Ph.D., M.A., St. John's College, Cambridge, Demonstrator of Chemistry, St. Bartholomew's Hospital.

In discussing the laws which govern substitution in the case of benzenoid compounds, Armstrong, in 1887, drew special attention to the peculiar behaviour of amido- and hydroxy-compounds, from which he inferred that the phenomena of substitution were less simple than was commonly supposed. He showed that there was evidence that the formation of para-derivatives was preceded by that of an isomeric compound formed by the displacement of the aminic hydrogen or hydroxylic hydrogen, and pointed to the probability that this might prove to be true also of ortho-compounds.

Since that time, it has been experimentally demonstrated by various chemists that the radicles, Cl, Br, I, NO_2, SO_3H, can all be introduced in place of the hydrogen of the amino-group of anilines and of the imino-group of anilides, and that the compounds thus formed can be changed into isomeric substances in which the substituent is contained in the hydrocarbon nucleus.

The transformation of the anilide derivative appears to take place only in the presence of some other substance: in the case of the phenylacylchloramines, such as $C_6H_5.NCl.COCH_3$, for example, apparently the change into the isomeric chloroacetanilides takes place only under the specific influence of hydrogen chloride (Compare Armstrong, *British Association Report*, 1899, p. 683; *Trans. Chem. Soc.*, 1900, vol. lxxvii., p. 1053). The investigation of such cases of isomeric change is, in fact, of special interest, as they are, so to speak, "fermentative" in character, often taking place with remarkable facility, and under the influence of minute amounts of the substance, which apparently provokes the change—the catalyst. Measurements of the velocity at which changes of this type occur, for example, of diazoaminobenzene into aminoazobenzene (Goldschmidt and Reinders, *Berichte*, 1896, vol. xxix., p. 1369), show that a velocity-coefficient of constant value is given by the equation—

$$k = t^{-1} \log a/(a-x).$$

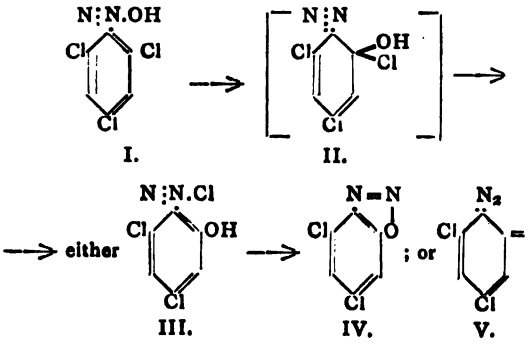
The isomeric change is, therefore, apparently a so-called monomolecular change; but, as in other cases, the slowest of the series of simple changes which make up the complete transformation is alone measured; moreover, the substance which conditions the change is not taken into account.

This paper deals with a new case of intramolecular change of a particularly interesting character: that of *s*-trichloro- and *s*-tribromobenzenediazonium hydroxide, $C_6H_2X_3.N(OH):N$, into hydroxybenzene derivatives, by the interchange of the hydroxyl for one of the ortho-halogen atoms. The change takes place under all conditions under which it is possible for the diazonium hydroxide to be present. Thus, in dilute aqueous solutions of the neutral diazonium nitrate, or even of the hydrogen sulphate, chloride is just recognisable by means of silver nitrate after twenty-four hours; at the same time the solution becomes yellow, owing to the formation of the diazophenol. But as the extent to which the nitrate, and more especially the sulphate, undergoes hydrolytic dissociation is extremely small, the isomeric change takes place very slowly; and in the presence of a considerable excess of acid no appreciable change occurs during five days. On the other hand, using diazonium acetate, 50 per cent of the material changes within thirty to forty hours; and in the case of diazonium bicarbonate the change is nearly instantaneous. That the change is a transformation of the diazonium hydroxide is further emphasised by the fact that the addition of a solution of the diazonium salt to a considerable excess of an aqueous solution of an alkali carbonate, is not followed by elimination of halogen; the solution remains colourless, the diazonium salt being immediately converted into the alkali diazotate.* The latter change may be represented thus—

$$\underset{\text{Diazonium salt.}}{C_6H_2X_3.NR:N} \rightarrow \underset{\text{Diazonium hydroxide.}}{C_6H_2X_3.N(OH):N} \rightarrow C_6H_2X_3.N:N\cdot OM'.$$

Diazotate.

As the author has maintained on previous occasions, the first step in this type of intramolecular change consists in a transference of the atom or group attached to the nitrogen to the ortho- or para-carbon atom of the nucleus, an ortho- or para-quinone being formed. The complete transformation in the case here described may be represented in the following manner:—



In other words, the diazonium chloride (III) may be represented as changing into the "diazophenol" (IV); or, if, following Wolff (*Annalen*, 1900, vol. cccxii., p. 119) and Hantzsch (*Berichte*, 1902, vol. xxxv., p. 888), the diazophenols are considered to be diazoquinones (V), the ortho-quinone form (II) merely loses hydrogen chloride.

Closely allied to the intramolecular change just mentioned, are Hantzsch's observations (*Berichte*, 1896, vol. xxix, p. 947; 1897, vol. xxx., p. 2334; 1898, vol. xxxi., p. 1253; 1900, vol. xxxiii., p. 505) that *s*-tribromobenzenediazonium chloride changes into chlorodibromobenzenediazonium bromide, and chloro- and bromobenzenediazonium thiocyanates into thiocyanobenzenediazonium chlorides and bromides.

(The following observations of Meldola (*Proc. Chem. Soc.*, 1901, vol. xvii., p. 131; *Trans. Chem. Soc.*, 1902, vol. lxxxi., p. 988) may also be mentioned, as the author's results offer a possible explanation. When dinitro-*o*- or dinitro-*p*-anisidine is treated with sodium nitrate in the presence of acetic acid, the nitro-group, occupying a position, ortho or para with respect to the amino-group, is eliminated, a diazophenol (diazo-oxide) being formed. In diazotising in the presence of hydrogen chloride, an ortho-nitro group is replaced by chlorine.)

The isomeric changes of the diazonium salts differ,

* A Paper read before the Royal Society, December 4, 1902.

* Professor Meldola has called the author's attention to a French patent (No. 315,932) of the Badische Aniline Company, dated Feb. 28, 1902, in which the replacement of the nitro-group and halogen by the hydroxyl-group *by the action of alkalis* on diazonium salts, is claimed as a technical process. The author's experiments show within what limits this process is applicable, and what is the probable action of the alkali.

however, somewhat from the similar changes of the phenylacylchloramines, phenylnitramines, &c. The latter compounds are *per se* relatively stable, and apparently only undergo changes in the presence of some agent (catalyst); the diazonium compounds, on the other hand, appear to be intrinsically labile, and in aqueous solution, at least, capable of passing into a more stable configuration. In the latter case the nitrogen atom, bearing the wandering group, the hydroxyl group (or, as in Hantzsch's instances, the chlorine atom or the thiocyanate group), is pentad, thus, $Ph.N(OH):N$, whilst in the phenylacylchloramines, &c., it is triad. The idea at once suggests itself that in the case of the last-mentioned compounds, the first action of the catalyst is to form an additive product, in which the nitrogen is pentad. The product, in which, it should be noted, more than one negative radicle is attached to the nitrogen, is not a stable compound, and is now capable of passing into the isomeric quinone form, and thus start the transformation.

These results are also of interest, inasmuch as Hantzsch (*Berichte*, 1902, vol. xxxv., p. 2964) has stated recently that he has obtained *s*-tribromophenylnitrosamine, $C_6H_2Br_3.NH.NO$, by adding sodium acetate to a solution of a *s*-tribromobenzenediazonium salt. He describes it as a bright yellow amorphous substance, which decomposes at 85°. As far as can be judged, it is this very reaction which has been studied in the course of the author's experiments. The substance which is precipitated is at first glance a yellow amorphous powder, but close observation shows that long (¼—1 c.m.) orange crystals are present. These crystals are the 3:5-dibromo-*o*-diazophenol hereafter described. The powder is probably a hydroxyazo-condensation product. Hantzsch does not appear to have observed that bromine is eliminated. He also affirms (*loc. cit.*) that he obtained the nitrosamine by the cautious addition of acetic (or other) acid to the alkali diazotate; in the writer's experience, however, this always leads to the elimination of halogen.

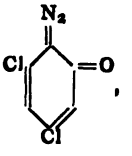
The Transformation of s-Trichlorobenzenediazonium Hydroxide.

s-Trichlorobenzenediazonium hydrogen sulphate, $C_6H_2Cl_3.N(SO_4H):N$, is very easily prepared by diazotising, by means of amyl nitrite, *s*-trichloraniline dissolved (or suspended) in glacial acetic acid containing sulphuric acid. The salt is precipitated by ether, and is purified by dissolving in methyl alchohol; on adding ether to this solution the sulphate separates in small colourless lustrous prisms, often forming star-shaped aggregates, which are very soluble in water (SO_4—found 31·0, calculated 31·4 per cent). *s-Trichlorobenzenediazonium nitrate*, $C_6H_2Cl_3.N(NO_3):N$, prepared in a similar manner, forms colourless needles. When kept for two or three days, both salts begin to show signs of change, which are more marked in the case of the nitrate. The latter becomes noticeably yellow, and when dissolved in water forms a yellow solution. The initially colourless aqueous solution of the pure colourless salts becomes yellow after a few hours; after twenty-four hours chloride is just recognisable in the solution. In one experiment, 0·5 grm. of the acid sulphate was dissolved in 100 c.c. of water; after three days a very small amount of a yellowish red solid had separated from the yellow solution; at the end of sixteen days, the chloride in solution was precipitated by silver nitrate in the presence of nitric acid: the silver chloride weighed 0·05 grm., whereas for the complete conversion of the diazonium salt into the diazophenol, 0·235 grm. of silver chloride should have been found.

An aqueous solution of *s*-trichlorobenzenediazonium acetate, obtained by mixing neutral solutions of the diazonium nitrate and sodium acetate (molecular proportions) rapidly becomes yellow and acid. In a short time the solution becomes turbid, and after four to five hours deposits a bright yellow amorphous solid. In an experiment, in which 1·75 grms. of the diazonium nitrate, dissolved in 150 c.c. of water, was treated with sodium acetate (1 mol.), and kept at 10—15° for forty hours in the dark, an estimation of the hydrogen chloride in the solution showed that 54·5 per cent of the diazonium compound had changed into the diazophenol.

When instead of sodium acetate, sodium hydrogen carbonate was used, a similar change took place, but far more rapidly. In one experiment a dilute aqueous solution of sodium hydrogen carbonate (3 mol.) was added drop by drop during a period of one hour to a cooled solution of 1 grm. of the diazonium hydrogen sulphate. (The bicarbonate was finally present in sufficient quantity to combine with the whole of the sulphuric acid and one-third of the chlorine present in the diazonium salt). After one-third of the bicarbonate had been added, and the acid converted into the normal sulphate, the solution rapidly became yellow and deposited a yellow solid. Throughout the experiment the mixture was acid. As soon as the whole of the bicarbonate was added, the chlorine was estimated; it represented 54·5 per cent of the amount which should be obtained were 1 atom of chlorine eliminated from the diazonium salt. In another experiment, using the same quantities of diazonium salt and sodium bicarbonate, the solutions were mixed as rapidly as possible; a copious yellow precipitate at once appeared; the chloride in the filtrate represented 72 per cent of 1 atomic proportion of chlorine.

3.5-*Dichloro o-diazophenol* (3.5-*dichloro-o-diazoquinone*),—



is contained in the yellow solutions which are obtained by any of the methods just described. It is best prepared by adding excess of sodium acetate to *s*-trichlorobenzenediazonium hydrogen sulphate or nitrate. The mixture should be kept during forty to fifty hours in the dark; in the light the solution darkens, the diazophenol decomposing. The liquid was then filtered from the amorphous yellow solid, made strongly acid with nitric acid, and extracted four or five times with ether. On evaporating the yellowish-brown extract, a mixture of oil and crystals remained. In order to obtain the diazophenol, dry hydrogen chloride was passed into the ethereal extract; this caused the *hydrochloride* of the dichloro-*o*-diazophenol, $O:C_6H_2Cl_2:N_2,HCl$, to separate in small needles. This salt was converted into the diazophenol by treatment with a small quantity of water. Thus prepared, the diazophenol is an orange powder, which crystallises from an ethereal solution in flattened orange prisms, which melt at 83—84°, forming a red liquid; at 87° the latter decomposes. On analysis, 0·1068 grm. gave 0·1618 grm. AgCl. Cl = 37·45.

0·2004 grm. gave 25·4 c.c. of moist nitrogen at 14° and 766 m.m. N = 14·95. $C_6H_2ON_2Cl_2$ requires Cl = 37·57; and N = 14·86 per cent.

This substance is very readily soluble in all solvents except petroleum; when dissolved in hot water it rapidly decomposes, the yellow solution becoming brown and turbid. It dissolves in concentrated solutions of acids, forming a nearly colourless liquid, which becomes yellow on adding water. These acid solutions couple with alkaline solutions of β-naphthol. There is no doubt that this substance is an ortho- and not a para-diazophenol, as *p*-diazophenols can be easily re-crystallised from hot water, whilst the ortho-compounds are decomposed by hot water. Again, *p*-diazophenols are easily reduced to *p*-aminophenols, but the ortho-derivatives are not reduced in a simple manner (Böhmer, *Journ. Prakt. Chem.*, 1881 [2], vol. xxiv., p. 460).

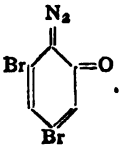
The amorphous yellow substances which are formed in the cases above described appear to be condensation products. The *o*-diazophenol which is produced has the para- and one ortho-position unoccupied, and being formed in the presence of a diazonium salt and sodium acetate or bicarbonate, is under conditions which are very favourable to the production of hydroxyazo-derivatives. A similar yellow powder is precipitated when sodium bicarbonate is added to a solution of the 3.5-dichloro-*o*-diazophenol. The yellow substances cannot be got to crystallise from any solvent; they decompose at 85°, and in a moist atmosphere slowly give off nitrogen; this is very noticeable when an attempt is made to estimate the nitrogen by Dumas' method. They do not dissolve in aqueous alkalis or acids. Cryoscopic determinations of the molecular weight in benzene show that, whether prepared by means of sodium acetate or bicarbonate, the molecule contains three benzeneazo-groups. There are three such compounds possible, formed by condensation either of (1) 2 mols. of *s*-trichlorobenzenediazonium salt with 1 mol. of the diazophenol ($(C_6H_2Cl_3.N_2)_2.C_6Cl_2\leqq^{N_2}_{O}$ has a mol. weight = 604; chloride = 46·8 per cent); or (2) of 1 mol. of the diazonium salt with 2 mols. of the diazophenol (mol. weight = 585·5; chlorine = 42·2 per cent); or (3) of 3 mols. of the diazophenol (mol. weight = 567; chlorine = 37·5 per cent). The material prepared by the use of sodium acetate has the highest percentage of chlorine, 44·7—44·9; its molecular weight was found to be 580—590; it is probably a mixture of (1) and (2). When bicarbonate is used, the yellow substance contains 41·4—43·7 per cent of chlorine; its molecular weight was found to be 560—580.

The Transformation of s-Tribromobenzenediazonium Hydroxide.

The transformation of *s*-tribromobenzenediazonium hydroxide resembles in its main features that of the *s*-trichloro-compound. *s*-Tribromobenzenediazonium nitrate, when first prepared, is pure white, although Silberstein (*Journ. Prakt. Chem.*, 1883 [2], vol. xxvii., p. 113) has described it as yellow. On keeping, it gradually acquires a yellow colour. Solutions both of the nitrate and the hydrogen sulphate become yellow, and bromine can be detected in the liquid. When either sodium hydrogen carbonate or sodium acetate is added to solutions of the salts, the decomposition is far more rapid. Thus in one experiment, in which sodium bicarbonate was added to a solution containing 1 grm. of the diazonium hydrogen sulphate, 0·31 grm. of silver bromide was obtained, whereas 0·508 grm. are required for the elimination of 1 atom of bromine.

In the presence of sodium acetate, the solutions of the diazonium salt rapidly become yellow and turbid. After twenty-four hours at 0°, a bulky and, at first glance, homogeneous precipitate had separated. In one experiment when 2 grms. of the sulphate were used, 0·58 grm. of silver bromide was obtained from the filtrate from the yellow precipitate. Careful examination of the yellow precipitate showed that it consisted of crystals completely covered and matted together by an amorphous yellow powder. These two substances could not be separated by crystallisation from any solvent. It was, however, found possible to obtain the crystals free from the powder by frequently shaking up the solid with water and decanting the supernatant liquor before the light powder had had time to settle.

3.5-Dibromo-o-diazophenol (*3.5-dibromo-o-diazoquinone*),



—The crystals just mentioned are the 3.5-dibromo-*o*-diazophenol in a state of purity. They are long slender transparent prisms of a fine orange colour, which explode when heated at 140°.

0·1894 grm. gave 0·2564 grm. AgBr. Br = 57·6.

(Two cryoscopic determinations of the molecular weight in benzene solution gave the values 278·9 and 281·6).

$C_6H_2ON_2Br_2$ requires Br = 57·53 per cent, and a molecular weight of 278.

The compound is very soluble in chloroform, benzene, ether, and glacial acetic acid, and in boiling alcohol. It is moderately soluble in boiling water, and very slightly so in cold water or petroleum. Treatment with hot water or alcohol decomposes it. It dissolves in concentrated acids, forming a colourless solution, and is re-precipitated by addition of water. The solution in acid couples with alkaline solutions of β-naphthol. The hydrochloride is obtained in nearly colourless needles by passing dry hydrogen chloride into a dry ethereal solution. This substance is without doubt the ortho-diazophenol, and not the 3·5-dibromo-*p*-diazophenol, which has been prepared by Silberstein (*loc. cit.*), and which can be crystallised from hot water.

In the account given by Hantzsch of the experiments above referred to, it is stated that on adding sodium acetate to the solution of a *s*-tribromobenzenediazonium salt, the whole of the latter is gradually converted into *s*-tribromophenylnitrosamine, $C_6H_2Br_3.NH.NO$, of which analyses are given: it forms an amorphous yellow powder, decomposing at 85°. By passing hydrogen chloride into the ethereal solution, he obtained a hydrochloride of the nitrosamine, which is immediately decomposed by water, a property possessed by the hydrochloride of the diazophenol.

The amorphous yellow powder, obtained by the author, both by the action of sodium hydrogen carbonate on the *s*-tribromobenzenediazonium salts, and mixed with crystals of the diazophenol when sodium acetate is used, decomposes at 85—90° (compare Hantzsch, 85°). The yellow substance appears to be similar to those obtained from *s*-trichlorobenzenediazonium salts; but determinations of the molecular weight indicate that only two benzeneazo-groups have condensed. In this case, however, the yellow powder certainly contained some of the diazophenol, as on passing hydrogen chloride into an ethereal solution of the powder, a small quantity of the hydrochloride of the last-mentioned substance separated.

(The investigation of these intramolecular changes is being continued. It has been found that a similar interchange of halogen for hydroxyl takes place very readily in solutions of chloro- and bromo-naphthalenediazonium salts, even in the presence of excess of acid. The author is of opinion that the observations of Gaess and Ammelburg (*Berichte*, 1894, vol. xxvii., p. 2211) that an aqueous solution of 1-nitro-2-naphthalenediazonium sulphate yields the 1:2-naphthalenediazo-oxide is an example of the type of transformation here considered).

The Detection of Chromic Acid by means of Peroxide of Hydrogen, in the presence of Vanadic Acid.—C. Reichard.—The blue reaction of peroxide of hydrogen with chromic acid is prevented by the presence of vanadic acid. This influence cannot be attributed to a simple peroxidation of the vanadic acid, since an excess of peroxide of hydrogen does not bring the colour back; it is comparable rather with the decomposing action of the peroxides on chloride of lime. The phenomenon can be observed up to one part of vanadate of ammonium in ten parts of bichromate of potassium; it is no longer observed in the presence of phosphate or arseniate of soda. The presence of molybdic or tungstic acids is also inimical to the reaction of the perchromic acid.—*Zeit. Anal. Chem.*, vol. xl., p. 577.

ON THE MATERIAL OF CERTAIN CYPRIOTE CYLINDER-SEALS.

By Professor A. H. CHURCH, M.A., D.Sc., F.R.S., F.S.A.

It was in August, 1899, that my attention was first drawn by Dr. A. S. Murray, of the British Museum, to a seal-cylinder from Cyprus, which presented certain curious features. At first sight it appeared to be an engraved hæmatite, but on further examination the seemingly incuse designs which cover it revealed the characteristics of a casting from a mould in relief, while the material itself proved to be too soft and too brittle for hæmatite. Still the surface possessed the submetallic lustre of that substance, though rather violet in hue. The specific gravity of the cylinder was ascertained to be 5·36—a figure near to but rather higher than that of the compact black hæmatite usually employed for Babylonian and Egyptian objects of this class. A clue to the composition of this cylinder was furnished by the presence of a pale greenish deposit which filled up a part of the hollow axis. This was found to contain much calcium carbonate, along with distinct traces of calcium sulphate and of a compound of copper. The calcium carbonate being obviously extraneous it was possible that the cylinder itself might have been the source of the sulphur and of the copper which had been detected—might in fact consist of or contain a sulphide of copper. This was proved to be the case by an examination of a few scrapings which responded to the tests, physical as well as chemical, for cuprous sulphide (Cu_2S), a compound which occurs in nature as the mineral copper-glance or chalcocite. Some comparative experiments with scrapings of copper-glance, and scrapings of this Cypriote cylinder, showed that these two materials were virtually, if not actually, identical. They could not be distinguished under the microscope; they were alike in degree of fusibilty and in hardness (about 3'). The specific gravity of the mineral ranges between 5·52 and 5·81, while the Cypriote cylinder under discussion was, it will be remembered, no higher than 5·36. But one expects to find a casting to be of lower density than the same material in a crystallised condition by reason of cavities and impurities in the former. And here I must refer to three other Cypriote cylinders of the same Mycenaean style, and obviously consisting of the same substance as the British Museum specimen. They are in the Ashmolean Museum at Oxford, and possess the specific gravities here recorded :—

Cylinder A (the largest)	5·504
Cylinder B (the next in size)	5·531
Cylinder C (the smallest)	5·313

These determinations, kindly made by Professor H. A. Miers, are in close accord with the figure I obtained from the British Museum example. I may add that I examined a few filings from Cylinder B, and found in them nothing save copper, sulphur, and traces of iron; indeed, in chemical as well as physical character, they correspond with cuprous sulphide. In this connection a fifth specimen should be cited. It is described in the "Catalogue of the Cyprus Museum" by J. L. Myres and Dr. M. Ohnefalsch-Richter as a cylindrical seal of the Bronze Age and of Mycenaean design. It is further stated that the design is "engraved on a black artificial paste resembling hæmatite," and that the material had been analysed by Dr. Weeren, of the Technological High School at Charlottenburg. I wrote to Dr. Weeren on the 19th of December, 1899, for details of his analysis, but have received no reply to my letter of inquiry.

The question now suggests itself, "Whence did the Mycenaean craftsman obtain his supply of cuprous sulphide?" At first I imagined that he might have had access to the mineral copper-glance, and have made a casting in a clay mould from this material after crushing and fusing it. But a more probable origin for this imitation of hæmatite was suggested to me by Mr. W. Gowland during my examination of a copper ingot, found in the year 1896 at Enkomi in Cyprus. This ingot (No. 113 in the British Museum Catalogue of Bronzes), which measures 2 feet 3¼ inches in length, 16 inches in breadth, and 2 inches in thickness, and weighs 81 pounds 10 ounces, bears upon its lower face the Cypriote character—

On analysing the unaltered central portion of this ingot the following figures* were obtained :—

	Per cent.
Copper	98·05
Tin	nil
Lead	0·31
Bismuth	trace
Silver	trace
Zinc	0·05
Iron	trace
Sulphur	0·22

Now the side-light thrown upon the special inquiry in hand comes from the recognition of sulphur in this ingot, and from the detection of particles of a very impure cuprous sulphide amongst the drillings of metal handed to me for analysis. Clearly the ore from which this ancient ingot of copper had been reduced must have contained a fair quantity of unoxidised sulphides. Mr. Gowland thinks the metal was produced "by smelting *surface* ores consisting of carbonates and oxides mixed with some sulphide." He further remarks, "whenever a certain amount of undecomposed sulphides was present, the products of direct smelting would be copper similar to the Cypriote ingot, and varying amounts of regulus resembling or identical with the material of the cylinders." Now this regulus, consisting mainly of cuprous sulphide but with some FeS, probably represented a product of the furnace intermediate between the "blue metal" and the "white metal" of the modern metallurgist. This then was, in all probability, the substance which, seen in its fused state, the Mycenaean artisan recognised as offering a superficial resemblance to polished hæmatite. It did more than present such resemblance, for it possessed almost the same density as the much harder ore of iron. Here, then, was the very material wanted for casting, by an easy process, these "shoddy" cylinders, as I may venture to call them. They were cheap and quickly-made imitations of laborious engraved work, executed upon comparatively hard hæmatite. I ought, perhaps, to add here that the bluish-black regulus, obtained as above mentioned, though essentially cuprous sulphide, is by no means of constant composition and density. It is, therefore, not to be expected that this group of Mycenaean cylinder-seals should present an absolute uniformity in chemical and physical properties.

A striking confirmation of the suggested origin of the material of these Cypriote cylinders is afforded by the occurrence on the largest of the Ashmolean examples of a very good representation of an ingot like the specimen from Enkomi which I have described in the present note. —*Proceedings of the Society of Antiquaries*, May 29, 1902.

Addition Products of Cyclohexane.—Léon Brunel.—The author prepares several new derivatives of cyclohexane, and examines their properties. Iodhydrine of orthocyclohexanediol, the iodhydrine ether oxides, the methylic ether oxide, the ethylic ether oxide, and orthochloroiodcyclohexane.—*Comptes Rendus*, cxxxv., No. 23.

* The amount available for analysis was 6 grms. only. The two determinations of copper which were made differed by 0·10 per cent; the mean is inserted in the table of results. I am indebted to Mr. F. W. Harbord for all the results, save the percentage of sulphur; this is probably over-stated.

ON THE GRAVIMETRIC ESTIMATION OF TELLURIUM.

By R. W. EMERSON MacIVOR, F.I.C., &c.

In the methods for gravimetrically estimating Te ordinarily given in the analytical text-books, the substance is thrown out of solution in the elementary state by sulphur dioxide, or other reducing agent, and weighed in that form, or, after treatment with nitric acid and subsequent heating to fusion, as TeO_2.

The use of SO_2 as a precipitant in the quantitative determination of this element was first proposed by Berzelius, and the modification of the great chemist's process, recommended by Fresenius ("Chemical Analysis," vol. ii., p. 419, seventh edition), consists in adding to the tellurous HCl solution a strong aqueous solution of SO_2, and allowing the mixture to remain a few days in a warm place "to ensure complete precipitation." Now, it was shown by some of the older chemists, and in later years by Schrœtter, Brauner, Norris, Fay, Crane, and Frerichs, that it is not possible to precipitate all the tellurium from a strongly acid solution by SO_2 only. Moreover, Brauner (*Journ. Chem. Soc.*, vol. lv., p. 392) points out that part of the precipitated element undergoes oxidation in the acid liquid, becoming converted into $TeCl_4$, in which form it remains in solution. Crane suggests (*Am. Chem. Journ.*, xxiii., p. 408—425) that the main cause of the incompleteness of the action is the very rapid increase of the ratio of the acids to the unprecipitated tellurium in solution, two-thirds of this being due to HCl set free, and one-third H_2SO_4 formed, and that if these could be removed the reduction would go on to the end. So far as the HCl is concerned, it could be got rid of by simple evaporation, but then the continuous increase of the H_2SO_4 would soon again interrupt the reaction. By the careful use of KHO or NaHO this increase of acidity might, of course, be kept under control, but Whitehead, in proposing the acid sodium sulphite as an efficient precipitating agent solved the difficulty once and for all. It is true that this salt does not completely remove all the tellurium from solution in the cold, but if not used in great excess and the mixed solutions be raised to boiling point, towards the end of the action the precipitation is perfect, and the tellurium obtained in a state of aggregation favourable to easy filtration—an important consideration when the liability of the precipitate to undergo oxidation is borne in mind. The solution of sulphite should be moderately concentrated, and the quantity added to the tellurous solution sufficient only to just neutralise the acids present and formed in the reaction. On thoroughly agitating the solutions together, and then allowing the mixture to stand in a warm place, the precipitate will be found to form and settle evenly. It may be found advantageous to decant or filter the liquid from this precipitate before heating it to boiling point to obtain the last portion of tellurium. However this may be done every precaution must be taken to guard against the access of air to the wet precipitate. It will be noticed that the precipitate brought down by boiling is lighter in colour than the other formed in the cold or in mere warmth, but chemically the two are identical.

The completeness of the action of acid sodium sulphite on solutions of tellurium has been proved by Crane in a remarkable manner. An HCl solution containing only 0·00000214 grm. Te per c.c. gave a distinct reaction! "An effective surface of about one-half a square centimetre of white filter-paper was used to collect the precipitate, and on this the layer of black tellurium was plainly visible." In a still weaker solution the presence of the element was discernible, but "it appears probable that this limit is due simply to the fact that we have here nearly reached the physiological limit of seeing black on white."

The process recently devised by G. Frerichs (*Journ. Prakt. Chim.*, lxvi. [17], 261—262) is based on the fact that the simultaneous presence of HI and SO_2 causes the immediate and complete separation of tellurium from tellurous solutions even in the cold. To the solution in HCl of about 0·3 grm. of TeO_2 diluted to 100 c.c. with water, one to two grms. KI are added, and the whole heated to boiling; about 50 c.c. of an aqueous solution of SO_2 is next added, and, after settling, the precipitate is collected on a tared filter, first washed with water containing some SO_2, and finally with alcohol and ether. In practical working I can confirm all Frerichs has said for his process: it is rapid, the precipitate obtained filters easily, and can be quickly washed.

Crane suggests the use of metallic magnesium as a perfect precipitant for tellurium from hydrochloric acid solution. It is essential that the quantity of acid present should be as small as possible, and that a slight excess of magnesium should be employed. This latter may be oxidised by vigorous boiling and the resulting $Mg(OH)_2$ dissolved by the addition of acetic acid. Crane is of opinion that the tellurium precipitated by this method is not so prone to oxidation as that obtained by other processes. On this point, however, I am not prepared to say anything, but two trials of the process made in my laboratory satisfied me as to the reliability of the new process; the tellurium came quickly out of solution, and "left not a trace behind."

The rapidity with which tellurium precipitates undergo oxidation forms the main objection to the substance being weighed in the elementary form. We have seen that the process takes place with part of the substance thrown out of strongly acid solution by SO_2, and that that part remains afterwards in the liquid in the state of tetrachloride. During the operations of washing and drying the absorption of oxygen may be very considerable; hence these should be carried out as expeditiously as possible, and the precipitates should be kept as well covered with water as practicable to exclude air. It has been estimated by Norris and Fay (*Am. Chem. Journ.*, xx., p. 278) that under ordinarily careful conditions of working the precipitated tellurium increases in weight about 0·5 per cent owing to oxidation, and that this increase is balanced by the quantity of the element oxidised and left behind as $TeCl_4$ in the strongly acid solution in which the precipitate was formed by SO_2. In this case "the two sources of error" tend to neutralise each other, and the result obtained by estimating tellurium as Te by SO_2 precipitation may be taken as approximately true. However, the chemists last named are of opinion that "of the two gravimetric methods, weighing as TeO_2 and in the elementary state, the former alone is accurate." Brauner considers the results obtained by weighing tellurium precipitates quite unreliable, but at the same time points out that in the TeO_2 method the nitric acid is not entirely driven off before part of the dioxide is volatilised. This latter fact notwithstanding, chemists generally agree with the view expressed by the American chemists.

I hope soon to be in a position to put forward in the columns of this journal a really reliable gravimetric way of estimating tellurium. My results to date are certainly promising, but the continuity of my work is at present much interfered with, or perhaps an account of the new process would have formed part of the present communication.

Annuaire du Bureau des Longitudes.—The firm of Gauthier-Villars (55, Quai des Grands-Augustins, Paris) have just published their usual annual volume, the *Annuaire du Bureau des Longitudes* for 1903. It forms a compact volume in 16mo. of about 850 pages with figures, and costs post paid 1fr. 85c. It contains a fund of information indispensable to the man of science. Among the articles in this year's volume we may specially draw attention to that by M. R. Radau "On Shooting Stars and Comets," that of M. J. Janssen "On Science and Poetry," and to the discourses delivered at the funeral obsequies of MM. Faye and Cornu.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Wednesday, December 17th, 1902.

Prof. J. Emerson Reynolds, Sc.D., F.R.S., President, in the Chair.

Certificates were read for the first time in favour of Messrs. Edwin Bayles Atkinson, Scarthe House, Great Grimsby; William Bowen Cleveden, Woodend Road, Erdington; R. C. Farmer, M.Sc., Ph.D., 154, Eglinton Road, Woolwich, S.E; Frederic Herbert Lees, 256, Park Road, Crouch End, N.; A. H. Scholefield, B.A., B.Sc., 4, Hartley Terrace, Wolverhampton; Charles Tilburn, 31, Hardy Street, South Yarra, Melbourne; Andrew Young, M.A., B.Sc., 1, Avenue Terrace, Cape Town.

The following certificates were authorised by the Council under By-law I. (3):—K. Bhaduri, M.A., Professor, Canning College, Lucknow; George Montagu Prichard, Ramtek, Nagpur, C.P., India.

Of the following papers, those marked * were read:—

*180. "*A Reagent for the Identification of Carbamide and of certain other Nitrogen Compounds.*" By H. J. H. Fenton.

In previous communications to the Society (Fenton and Gostling, *Trans.*, 1899, lxxvii., 423; 1901, lxxxi., 807), various derivatives of methylfurfural have been described which are obtained from ketohexoses, or substances which produce these on hydrolysis, and from cellulose. Amongst these derivatives, a crystalline condensation product was mentioned having the formula $C_{11}H_8O_4$, the constitution of which is still under investigation; the evidence obtained so far indicates that it is either methylfuril, $C_4H_3O{\cdot}CO{\cdot}CO{\cdot}C_4H_2O{\cdot}CH_3$, or the ketone-aldehyde, $CHO{\cdot}C_4H_2O{\cdot}CO{\cdot}C_4H_2O{\cdot}CH_3$. The method of obtaining this substance has been considerably improved, so that it is now easy to prepare it in quantity. If a small quantity of this product be mixed with urea and the mixture treated with a trace of phosphorus oxychloride, acetyl chloride, or dry hydrogen chloride—dissolved in any appropriate solvent—a very brilliant blue colour is obtained. The reaction is one of extreme delicacy, 0·1 milligrm. of urea giving a strongly marked colour, and with care it is quite easy to detect 0·01 milligrm. or less.

This effect is due to a colourless base of which the salts have a blue colour. The intensity of the colour of these salts in aqueous solution varies markedly with the nature and concentration of the acid.

The production of a blue colour in the manner here described is characteristic of carbamide and of monosubstituted carbamides, $NH_2{\cdot}CO{\cdot}NHR$, in which the substituting radicle is an alkyl group or one of a similar character; acidyl substituted carbamides give no such reaction. Urethane gives a similar reaction, but the colour is red by transmitted light.

This compound also reacts with primary amines in acetic acid solution to give very brilliant green compounds; this change is produced at once on simply mixing the solutions without any condensing agent, and appears to be quite characteristic of primary amines.

Discussion.

Mr. C. E. Groves asked whether oxalic acid behaved like sulphuric and hydrochloric acids.

Mr. Fenton replied that the base gave a blue colour with oxalic acid also, the intensity of the colour being greater than that produced with acetic acid, but less than that with hydrochloric acid.

*181. "*The Rate of Decomposition of Diazo-compounds. Part II. Diazo-compounds of the Naphthalene Series.*" By J. C. Cain and F. Nicoll.

The authors have extended their researches on the decomposition of diazo-salts (*Trans.*, 1902, lxxxi., 1412) to those of the naphthalene series, and find that the reaction is a unimolecular one in the case of the soluble diazo-salts prepared from the following amines:—

1. α-Naphthylamine.
2. β-Naphthylamine.
3. Naphthylaminesulphonic acid .. .. $NH_2 : SO_3H = 1 : 8$.
4. Naphthylaminesulphonic acid .. .. $NH_2 : SO_3H = 2 : 6$.
5. Naphthylaminesulphonic acid .. .. $NH_2 : SO_3H = 2 : 7$.
6. Naphthylaminedisulphonic acid .. .. $NH_2 : SO_3H : SO_3H = 2 : 6 : 8$.
7. Naphthylaminedisulphonic acid .. .. $NH_2 : SO_3H : SO_3H = 2 : 3 : 6$.
8. Amidonaphtholdisulphonic acid .. .. $NH_2 : OH : SO_3H : SO_3H = 1 : 8 : 3 : 6$.

The unimolecular reaction, however, in the case of Nos. 1, 2, 4, 5, 7, 8, is hindered, after a considerable amount of decomposition has taken place, by the formation of azo-colours, which is clearly shown by the rapid diminution of the values of C, calculated according to the equation—

$$\frac{1}{t} \log \frac{A}{A - x} = C \text{ (a constant).}$$

The measurements were made at 60°, except in the case of No. 8, when the temperature was 80°. The diazo-salts are thus very stable.

In the case of the insoluble diazo-salts obtained from the following amines:—

9. Naphthylaminesulphonic acid, $NH_2 : SO_3H = 1 : 2$.
10. " " " $= 1 : 4$.
11. " " " $= 1 : 5$.
12. Amidonaphtholsulphonic acid, $NH_2 : OH : SO_3H = 2 : 8 : 6$.

the rate of decomposition is expressed by the equation $\frac{x}{t} = K$ (a constant), x being the observed volume of nitrogen evolved in the time t.

In each case, an azo-colour is formed towards the end of the reaction, shown again by the rapid diminution of the values of K.

These diazo-salts are very stable, the experiments being made at 70° or 80°.

In each case where an azo-colour is formed, the value of C or K is constant for a considerable period, showing that, although both naphtholsulphonic acid and diazo-salt are present, no combination takes place during this period.

The authors suggest that this interesting fact may be explained by assuming that hydrolytic dissociation of the diazo-salt is necessary before combination takes place; in the above experiments, the diazo-salt is not dissociated (especially in the presence of the free mineral acid, which has a retarding effect on the formation of an azo-colour) until its concentration becomes considerably less. When this point is reached, the formation of an azo-colour can proceed.

*182. "*State of Carbon Dioxide in Aqueous Solution.*" By J. Walker.

The author gave a proof from the law of mass-action that carbonic acid (and similar substances) in aqueous solution must obey Ostwald's dilution law, independently of the proportions of the anhydrous and hydrated forms contained in the solution. The conclusion formerly drawn (Walker and Cormack, *Trans.*, 1900, lxxvii., 8), that the carbon dioxide in solution is probably hydrated to the extent of 20 per cent, must therefore be rejected.

*183. "*Qualitative Separation of Arsenic, Antimony, and Tin.*" By J. Walker.

When a solution of the sodium thio-salts of arsenic, antimony, and tin is boiled with sodium peroxide, these

salts are converted into sodium arsenate, antimonate, and stannate respectively. Any mercury which may have been dissolved from the copper group on warming with sodium hydroxide, is, by this treatment, re-precipitated as sulphide. The tin may be separated from the arsenic and antimony by boiling with excess of ammonium chloride, which precipitates stannic hydroxide, leaving the antimony and arsenic in solution. On addition of excess of acid, these may be separated by means of sulphuretted hydrogen in the cold, the antimony being at once precipitated as sulphide, whilst the arsenic remains dissolved.

Discussion.

Dr. F. M. Perkin remarked that when stannous sulphide does not dissolve in caustic alkali, the addition of a little sodium or hydrogen peroxide enables it to do so. The peroxide seems to exert very little, if any, oxidising action upon the sulphides of the copper group, hence there is no objection to warming the mixed sulphides of these two groups with caustic alkali and sodium peroxide, and so obviating the use of ammonium sulphide.

*184. "*The Hydrates and Solubility of Barium Acetate.*" By J. Walker and W. A. Fyffe.

The authors have been unable to confirm the observations of Krasnicki (*Monatshefte*, 1887, viii., 601), who stated that the solubility of barium acetate between 0° and 80° could be represented by a single curve concave to the temperature axis. On the contrary they find that the solubility is expressed by three curves (for the trihydrate, monohydrate, and anhydrous salt, respectively), which are all convex to the temperature axis. The curve for the monohydrate exhibits a minimum at 30°, and that for the anhydrous salt a minimum at 75°.

The solubility and special dilatometric experiments showed the inversion temperature for—

$$Ba(C_2H_3O_2)_2,3H_2O \rightleftarrows Ba(C_2H_3O_2)_2,H_2O + 2H_2O$$

to be 24·7°; that for—

$$Ba(C_2H_3O_2)_2,H_2O \rightleftarrows Ba(C_2H_3O_2)_2 + H_2O$$

being 41°.

Discussion.

Professor Tilden expressed the belief that revision of many of the accepted data in regard to solubility was urgently required, and hoped that Professor Walker would continue his work in this direction. Published estimations of solubility of many metallic salts at temperatures above the boiling-point of water were absolutely valueless, inasmuch as evident chemical change sets in and basic salts are visibly deposited.

*185. "Cis- *and* trans-*αβ-Dimethylglutaric Acid and the Separation of the* cis- *and* trans-*forms of Substituted Glutaric Acids.*" By J. F. Thorpe and W. J. Young.

The αβ-dimethylglutaric acids are best prepared by the condensation of ethyl β-methylacrylate with ethyl sodiocyanacetate and subsequent treatment of the sodium derivative formed with methyl iodide.

Ethyl α-cyano-αβ-dimethylglutarate,—

$$CO_2Et\cdot C(CN)(CH_3)\cdot CH(CH_3)\cdot CH_2\cdot CO_2Et,$$

is a colourless oil which boils at 185° (20 m.m.), which, with cold methyl alcoholic potash, yields the *potassium* salt. *α-Cyano-αβ-dimethylglutaric acid* is a white solid which separates from ether and light petroleum in microscopic needles melting at 132—133°.

When this substance is heated with concentrated hydrochloric acid, it is in part converted into *αβ-dimethylglutarimide*,—

$$CH_3\cdot CH\begin{matrix}<\\ \\ \end{matrix}\begin{matrix}CH(CH_3)\cdot CO\\ CH_2 \text{ —— } CO\end{matrix}\begin{matrix}>\\ \\ \end{matrix}NH,$$

which crystallises from water in long needles melting at 113°, and in part into trans-*αβ-dimethylglutaric acid*, which appears to be a liquid at the ordinary temperature.

The imide, on hydrolysis with sulphuric acid, yields *cis-αβ-dimethylglutaric acid*, which crystallises from concentrated hydrochloric acid in needles melting at 87°.

The *trans*-acid is unacted upon by acetyl chloride, but when boiled with acetic anhydride or when slowly distilled under atmospheric pressure it is converted into the *anhydride* of the *cis*-acid, which may also be prepared by the action of acetyl chloride on the *cis*-acid. It is a liquid boiling at 255° (765 m.m.). The *anilic acid* separates from dilute alcohol in lustrous plates melting at 149°. The *cis*-acid, on heating in a sealed tube with concentrated hydrochloric acid, is converted into a mixture of the *cis*- and *trans*-acids.

The authors described the preparation of *αβ-dimethylpropanetricarboxylic acid*,—

$$(CO_2H)_2:C(CH_3)\cdot CH(CH_3)\cdot CH_2\cdot CO_2H,$$

which crystallises from dilute hydrochloric acid in white needles melting with evolution of carbon dioxide at 165°. When heated to 200°, this acid is converted into a mixture of *cis*- and *trans-αβ*-dimethylglutaric acids.

The *cis*- and *trans*-forms of substituted glutaric acids may be separated by converting the mixed acids into their ammonium salts, and heating them in a sealed tube at 160° for four hours. In this way, the ammonium salt of the *cis*-acid is converted into the imide, which, on hydrolysis with sulphuric acid, yields the *cis*-acid, whilst the *trans*-ammonium salt remains unchanged. The imide and ammonium salt are separated by means of ether.

The separation of *cis*- and *trans-αα'*-dimethylglutaric acids, of *cis*- and *trans-α*-methyl-*β-iso*propylglutaric acid, and of *cis*- and *trans-αα'ββ*-tetramethylglutaric acids have been thus effected.

*186. "*Constitution of Metallic Cyanides.*" By J. E. Marsh.

Volhard (*Annalen*, 1890, cclix., 378) has shown that potassium cyanide is oxidised by potassium permanganate to potassium cyanate. Other cyanides are similarly oxidised. Ammonium cyanide is thus converted directly into urea. There are two exceptions among metallic cyanides; silver and mercury cyanides are not oxidised by potassium permanganate. This reaction brings the cyanides of silver and mercury into relationship with the nitriles, which are also unattacked. On the other hand, the other cyanides are brought into association with the readily oxidisable carbamines. The author thinks that silver cyanide should be represented as Ag·C:N, and potassium cyanide as K·N:C.

Discussion.

Dr. Wade said he thought it was unsafe to infer a difference in the constitution of potassium and silver cyanides from the difference in behaviour of these salts towards oxidising agents. The potassium salt is freely ionised in aqueous solution, whilst the silver salt is insoluble and not appreciably ionisable; the stability of the latter towards oxidising agents is thus explained without having recourse to the hypothesis of a nitrilic constitution. Potassium cyanide resembles the alkyl *iso*cyanides in readily undergoing oxidation, as in most other respects (*Trans.*, 1902, lxxxi., 1606), but its ready ionisability in in this case destroys the parallel; the products of the oxidation of the undissociated alkyl *iso*-cyanides are complex and not comparable with the alkali cyanates, which are formed by the oxidation of *iso*-cyanogen ions.

*187. "*Auto-reduction of Mercury and Silver Cyanides.*" By J. E. Marsh and R. de J. F. Struthers.

On the hypothesis that silver and mercury cyanides have the nitrile constitution, attempts have been made to bring about the hydrolysis of the (CN) group, if possible without breaking off the metal. In all the reactions tried in which the (CN) group is hydrolysed, it is broken off from the metal.

When mercuric cyanide is heated with a strong solution of potassium hydroxide, the salt is reduced to metallic mercury. The same reduction is brought about by boiling the salt with a solution of sodium or potassium hydroxide or ethylate in excess of alcohol. Cyanide and cyanate of the alkali are formed. The alkali cyanide

formed protects the mercury salt from reduction, so that only half of the mercury is reduced. If potassium cyanide be previously mixed with the mercury salt, no reduction occurs. An intermediate product is being further investigated. Silver cyanide is also reduced in the same way.

When mercury cyanide is heated with from sixty to eighty times its weight of a mixture of equal volumes of sulphuric acid and water, hydrogen cyanide, and carbon dioxide are evolved at about 130°, and the whole mass sets to a jelly, from which mercurous sulphate is obtained on filtration; ammonium sulphate is also formed. The decomposition of the cyanide may be represented thus:—$2HgC_2N_2+2H_2O+H_2SO_4=Hg_2SO_4+3HCN+CO_2+NH_3$. The decomposition of the cyanide is, however, not complete, and if the temperature is allowed to rise above 140°, whether the precipitate is previously removed or not, a further reduction takes place, with separation of metallic mercury. If mercury cyanide is heated with water in a sealed tube, the salt is completely decomposed, giving mercury, carbon monoxide, and ammonium carbonate. The reaction begins below 230°, and may be thus expressed—$HgC_2N_2+4H_2O=Hg+CO+(NH_4)_2CO_3$. No oxalic acid was obtained, but it was found that ammonium oxalate, under the same conditions, breaks up into carbon monoxide and ammonium carbonate. Silver cyanide is also reduced to metallic silver when heated with water.

188. "*Note on the Action of Acids on Cellulose.*" By Miss M. Gostling, B.Sc.

In previous communications it has been shown that all forms of cellulose, when heated to about 80° with a saturated solution of hydrochloric or hydrobromic acid in chloroform or carbon tetrachloride, yield ω-chlorobromomethylfurfural, and that dextrose (which could be extracted with water after separation of the methyl furfural derivative) was formed at the same time. Hence the presence of a ketose as well as an aldose nucleus in cellulose was conclusively proved.

In every case, about 40 per cent of a black residue which retained the fibrous structure of the original cellulose was left after the action of the acids.

In the hope of throwing further light on the constitution of cellulose, the nature of this residue was investigated, and it was prepared free from any of the original cellulose by repeated treatment with hydrochloric acid until no more of the furfural derivative was formed.

Chlorine acted very slowly on this black residue, giving yellow derivatives containing from 25·7 to 34·35 per cent of chlorine.

The action of bromine was similar.

Nitric acid (sp. gr. 1·2) and alkaline permanganate oxidise it to oxalic acid.

The original black residue is quite insoluble in alkalis, water, alcohol, ether, and other organic solvents.

The composition and general character of this residue is therefore closely allied to the substances known as artificial humus, obtained by Conrad and Guthzeit and by Sestini by the action of dilute acids on sugars. It corresponds most nearly with sacculmin (prepared by Sestini by boiling cane-sugar with dilute sulphuric acid), which was a black, amorphous mass, insoluble in potash solution, giving with chlorine yellow chlorine compounds. Sestini gives to sacculmin the formula $C_{44}H_{38}O_{15}$ (C=65·5; H=4·8 per cent), a slightly higher percentage of carbon and hydrogen than that in the black residue from cellulose (found C=62·31 to 62·70; H=3·64 to 4·29).

189. "*Nitrotartaric Acid and some of its Ethereal Salts.*" By P. F. Frankland, H. L. Heathcote, B.Sc., and Miss H. Hartle, B.Sc.

The announcement in the current number (December 6th) of the *Berichte* that a paper is to be communicated to the Berlin Society on December 8th by Professor P. Walden on the nitromalic and nitrotartaric esters, compels the authors to publish without delay the results of work on which they have been engaged during the past four years.

Their investigation has included the preparation and characterisation of the following compounds:—Dinitrotartaric acid, dimethyl dinitrotartarate, diethyl dinitrotartrate, dimethyl mononitrotartrte, and diethyl mononitrotartrate. Of these, dinitrotartaric acid was first obtained by Reinsch (*Jahrb.*, 1849, 329) and Dessaignes (*Jahrb.*, 1852, 475), whilst Henry (*Ber.*, 1870, iii., 530) professes to have prepared diethyl dinitrotartrate; the other compounds are, as far as the authors are aware, described for the first time. The only reference to the optical properties which they have been able to discover in chemical literature is the statement by Dessaignes that Chautard had found dinitrotartaric acid to be optically active and dinitroracemic acid inactive. With regard to diethyl dinitrotartrate, the authors are of opinion that Henry must have been dealing with the mononitrotartrate, inasmuch as he gives no analysis, and the melting-point 45—46°, which he records is very different from that which the authors have found, 27°, for the dinitro-, but very similar to that, 47°, which they have found for the mononitro-compound.

The authors have determined the optical activity of all these compounds dissolved in methyl and in ethyl alcohol, and, except in the case of dinitrotartaric acid, in benzene also.

The influence on the optical activity of the introduction of the nitro-group into the molecules concerned was also discussed.

190. "*The Nitration of Diethyl Monobenzoyl- and Mono-p-toluyl-tartrates.*" By P. F. Frankland, H. L. Heathcote, B.Sc., and C. J. Green, M.Sc.

For the reasons given in the preceding abstract, the authors wish to communicate the results which they have obtained in this investigation, which was also commenced four years ago.

Diethyl mono-benzoyltartrate and mono-*p*-toluyltartrate were nitrated in the hope of obtaining their mono-nitrates. In both cases, however, only compounds in which the nitro-group had entered the benzene ring were obtained. By hydrolysis it was shown that the *m*-nitrobenzoyl group was present in the one case, and the nitro-*p*-toluyl group ($CH_3:NO_2:CO=1:2:4$) in the other.

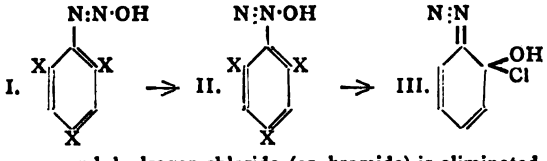
The rotation of these compounds was determined in solution in ethyl alcohol, ethyl acetate, benzene, pyridine, and chloroform. Their optical activity was enormously influenced by the solvent; thus the mono-*m*-nitrobenzoyl compound was inactive in benzene, although it exhibited considerable activity in the other solvents employed.

191. "*Interchange of Halogen for Hydroxyl in Chloro- and Bromonapthalenediazonium Hydroxides.*" (Preliminary notice.) By K. J. P. Orton.

It has recently been shown by the author that *s*-trichloro- and *s*-tribromo-benzenediazonium compounds undergo a remarkable isomeric change under certain conditions. If aqueous solutions of such salts as the diazonium nitrate or hydrogen sulphate are kept for a short time, the presence of chloride may soon be recognised by means of silver nitrate; at the same time, the solution becomes yellow, owing to the formation of the *o*-diazophenol (*o*-diazoquinone). The salts of a weak acid, such as the acetate, undergo the same change far more rapidly.

These facts lead to the conclusion that this change is a transformation of the diazonium hydroxide, $C_6H_2X_3{\cdot}N(OH):N$, formed by hydrolytic dissociation; the weaker the acid, the larger would be the proportion of the diazonium hydroxide present at any one time, and consequently the more rapid the change. Moreover, the presence of a sufficient excess of acid stops the change. Treatment with excess of alkali (hydroxide or carbonate), on the other hand, does not effect the elimination of halogen, but merely converts the diazonium compound, $C_6H_2X_3{\cdot}N(A):N$, into the diazotate (*iso*- or *anti*-diazotate), $C_6H_2X_3{\cdot}N:N{\cdot}OM'$. If dilute acid is cautiously added to a solution of the di-

azotate, halogen is also eliminated. On treatment with acid, the alkali diazotate should first of all yield the corresponding acid, the diazohydrate, $C_6H_2X_3{\cdot}N{:}N{\cdot}OH$, but as is well known, these acids appear to change immediately into neutral substances, probably primary nitrosoamines. In the reaction here described, it would seem that the diazo-hydrate (I.) is either transformed into the diazonium hydroxide (II.) (or its ions), and then into a complex (III.) of the quinone type, or else directly into this complex; from this quinonoid



compound, hydrogen chloride (or bromide) is eliminated, and a diazoquinone produced, or the halogen wanders to the nitrogen, a phenol diazonium salt being formed.

As the tendency to pass into the quinone type seems to be greater in the naphthalene series than in the benzene series, it would be expected that this transformation would take place with greater readiness in the case of naphthalenediazonium compounds. Meldola and Streatfeild (*Trans.*, 1895, lxvii., 908), who first observed this type of replacement of bromine by hydroxyl, have obtained 4-bromo-2-diazo-1-naphthol by treatment of 1:-4-dibromo-2-naphthylamine, dissolved in acetic acid, with sodium nitrite, and subsequent boiling of the mixture with water. The author has studied the transformation of chloro- and bromo-naphthalenediazonium oxides, the solid salts of which have not hitherto been prepared.

1-Chloro-2-naphthalenediazonium hydrogen sulphate, $C_{10}H_6Cl{\cdot}N(SO_4H){:}N$, prepared from 1-chloro-2-napthylamine, can be obtained (but with considerable difficulty) in the form of colourless needles, very soluble in water and acetic acid and moderately so in methyl alcohol. Exposed to the air, the crystals become yellow in a few minutes. The aqueous solution of the hydrogen sulphate, which is of course strongly acid, very rapidly becomes yellow and turbid. In the presence of sodium acetate, the change was complete in a few hours, and 2-diazo-1-naphthol (2-diazo-1-naphthoquinone), $O{:}C_{10}H_6{:}N_2$, had separated in long, slender, golden-yellow needles (m. p. 76—77°); at the same time, a small quantity of an amorphous, yellow solid containing chlorine was formed; it is probably an azo-condensation product. The chloride formed in the solution fell but little short of that contained in the diazonium salt. On passing dry hydrogen chloride into an ethereal solution of the diazonaphthol, a nearly colourless, crystalline *hydrochloride* is obtained.

2:4-Dibromo-1-naphthalenediazonium hydrogen sulphate, $C_{10}H_5Br_2{\cdot}N(SO_4H){:}N$, crystallises in colourless needles which are considerably more stable than the β-naphthalene derivative just described (compare Knoevenagel, *Ber.*, 1895, xxviii., 2052). The aqueous solution of this salt rapidly becomes yellow, and after a short time begins to deposit the diazonaphthol in small rosettes of needles. In the presence of sodium acetate, the diazonium salt is completely decomposed in twenty-four hours, one atomic proportion of bromine being found in the solution. *4-Bromo-1-diazo-2-naphthol* (*4-bromo-1-diazo-2-naphthoquinone*), $O{:}C_{10}H_5Br{:}N_2$, crystallises from dilute alcohol in rosettes of bright yellow needles, which melt and decompose with evolution of gas at 132—133°; it yields a nearly colourless *hydrochloride*.

192. "*Purpurogallin.*" By A. G. Perkin and A. B. Steven.

The discovery of Nietzki and Steinmann (*Ber.*, 1887, xx., 1277) that purpurogallin, on distillation with zinc dust, yields naphthalene has been confirmed. On methylation, purpurogallin gives a *trimethyl ether*, $C_{11}H_5O_2(OCH_3)_3$, orange-yellow needles, m. p. 174—177°, which forms a *monoacetyl* derivative, $C_{11}H_4O_2(OCH_3)_3{\cdot}C_2H_3O$, needles, m. p. 140—143°, and by the action of alcoholic potash at 170° yields a crystalline acid, m. p. 197—199°. The latter, on distillation, is converted into an anhydride, m. p. 164—166°. By digestion with 50 per cent potassium hydroxide solution, purpurogallin is converted into two isomeric compounds possessing almost identical reactions, to which the names *purpurogallone* and *iso-purpurogallone* have been given. The former, minute yellow needles, m. p. 260—262°, has probably the formula $C_{11}H_6O_5$, and gives the anhydroacetyl compound, $C_{11}H_2O_4(C_2H_3O)_2$, colourless, prismatic needles, m. p. 174—176°, whereas the latter, $C_{11}H_6O_5$, yellow needles melting above 300°, gives, with acetic anhydride, the compound $C_{11}H_2O_4(C_2H_3O)_2$, colourless, prismatic needles, m. p. 280—282°. It is probable that both compounds contain a carboxyl group.

193. "*Note on the Destructive Distillation of Ethyl Gallate.*" By A. G. Perkin.

According to Schiff (*Annalen*, 1872, clxiii., 217), on distillation, ethyl gallate gives pyrogallol and ethyl alcohol. This is so, but at the same time, towards the end of the operation, a considerable quantity of a red colouring matter sublimes, which has been identified as *rufigallic acid* (hexahydroxyanthraquinone) (found, C = 55·14; H = 2·63), by its acetyl derivative, $C_{14}H_2O_4(C_2H_3O)_6$ (found, C = 55·78; H = 3·85; $C_{14}H_8O_4$ = 55·09), m. p. 282—283° (not previously given), and by its dyeing properties. The yield was approximately 7 per cent, but considerable carbonisation occurs when this colouring matter is distilled. The reaction may be expressed as $2C_6H_2(OH)_3{\cdot}CO_2Et = C_{14}H_8O_8 + 2EtOH$. Gallic acid itself, on distillation, yields a small quantity of the same substance (acetyl compound, C = 56·17; H = 3·77), whilst protocatechuic acid and its ethyl salt give a trace of a colouring matter resembling rufiopin. β-Resorcylic acid does not give rise in this way to any anthraquinone derivative,

194. "*A Series of Double Chromates.*" By S. H. C. Briggs.

The author has found that freshly precipitated copper hydroxide or carbonate dissolves in one equivalent of chromic acid to give a clear solution in the presence of twenty or thirty equivalents of copper sulphate, or ten to fifteen equivalents of copper silicofluoride, although in the absence of these salts the dichromate and a precipitate of basic salt are produced.

A double salt, $(NH_4)_2Ni(CrO_4)_2{,}6H_2O$, was obtained by adding ammonium chromate to a solution of a nickel salt. This could be re-crystallised from water below 40°, although nickel chromate has never been obtained from aqueous solution, and ammonium chromate can only be re-crystallised from solutions containing ammonia. Attempts to prepare the potassium nickel chromate and double chromates of ammonium and copper, zinc, cadmium, and manganese were unsuccessful.

By the action of ammonia on the mother liquors from the preparation of $(NH_4)_2Ni(CrO_4)_2{,}6H_2O$ from the chloride, a double salt, $(NH_4)_2Ni(CrO_4)_2{\cdot}2NH_3$, was obtained, and corresponding copper, zinc, and cadmium compounds were formed by the action of ammonia on the dichromates. These double salts, on heating, lose water and ammonia, and undergo sudden decomposition between 200° and 300°, leaving a mixture of oxides.

Para-benzene-azobenzoic Aldehyde and its Derivatives.—P. Freundler and M. de Laborderie.—Since their original preparation of *p*-benzene-azobenzoic aldehyde the authors have discovered a method of preparing this aldehyde which avoids the separation of the two mixed symmetric acetals and the condensation of the nitroso-benzene with *p*-amino-benzoic aldehyde. This aldehyde being difficult to manipulate on account of its easy polymerisation, the authors try to substitute one of its immediate derivatives. *p*-Benzene-benzaldoxime, $C_6H_5N{=}NC_6H_4CH{=}NOH$, is described.—*C. R.*, No. 24.

NOTICES OF BOOKS.

The New Volumes of the Encyclopædia Britannica. The Seventh of the New Volumes, being Vol. XXXI. of the Complete Work. London: *The Times*. Edinburgh: Adam and Charles Black. 1902. Pp. 909.

The subjects included in this volume are those coming within the alphabetical headings MOS (Mosaic) and PRE (Prevasa).

The general standard of interest is well maintained in this volume, but the subjects of special scientific interest are fewer than in some of the earlier volumes.

The articles on "Motor Vehicles," by the Hon. C. S. Rolls and Professor H. S. Hele-Shaw, F.R.S., will be read with interest; of these two writers the former is well known as one of the foremost exponents of the practical side of the subject, while the last named is more closely allied with its theoretical aspect; in his recent Christmas lectures at the Royal Institution he took motor vehicles as one of his principal subjects.

To those mathematically inclined there are several articles worth attention, such as the "Laws of Motion," by W. H. Macaulay, and "Number," by G. B. Matthews, F.R.S. The series of articles on "Ordnance" by a number of distinguished writers, is of importance, and is fully illustrated. "Ore-dressing," by R. H. Richards, B.Sc., is of considerable interest to mining engineers and metallurgists; the author has divided his subject into three parts:—(1) The properties of minerals which render aid in their separation; (2) simple operations; and (3) operations combined to form processes or mills. With regard to properties, specific gravity is the most important in ore-dressing by settlement, either in air or water, but for hand-picking, colour, lustre, and fracture are of special value. Among the simple operations described and illustrated, the rock-breaker, the rolls, and the stamp mills are the principal, and after being treated in one or more of these, the crushed ore has to be concentrated; this operation can be done in a variety of manners, by buddles, jigs, vanners, &c.; these necessitate combined operations, and some of the more important of these mill schemes are described, such as those for zinc, lead, copper, tin, iron, gold, and asbestos ores, &c.

The "Oyster Industry" is one which has come prominently before us quite recently, owing to the unfortunate pollution of some oyster-beds by sewage; in the article dealing with this subject the writer gives a goodly number of statistics as to how many millions are sold, but no mention is made as to the very necessary precautions which should be taken in laying and stocking beds against their pollution by the sewage from neighbouring towns, discharged in the vicinity.

"Photography" is ably treated by Sir W. Abney and others, the subject being divided into three parts:—Scientific, apparatus, and pictorial. The "Phonograph," by J. G. M'Kendrick, is well written, and contains a number of interesting diagrams of vibrations or sound-waves of different languages, &c. Among other attractive articles, we may mention those on "Pneumatic Tools," "Oceanography," "Pathology," &c.

Physico-Chemical Tables; for the Use of Analysts, Physicists, Chemical Manufacturers, and Scientific Chemists. In Two Volumes, each complete in itself. Vol. I. *Chemical Engineering and Physical Chemistry*. By John Castell-Evans, F.I.C., F.C.S. London: Charles Griffin and Co., Ltd. 1902. Pp. 548.

This work has been designed to be of use to all engaged or interested in any branch of chemistry and metallurgy; it covers more ground than in any of the well-known "pocket-books," to which it is perhaps hardly fair to compare it, as it stands on a different footing to most of them. The author's first intention was to make two separate collections of tables, one for practical men and manufacturers, and the other for purely scientific investigators and college professors, but it was found to be impossible to make the division. Not only would there have been a great deal of overlapping, but there was also the thought that the practical man is rapidly finding that what was but recently a purely scientific method, is now a commercial and manufacturing process; in fact, the laboratory is invading and absorbing the works; in other words, our science is becoming more practical and our works more scientific. For such reasons it was decided to combine both kinds of tables in one work.

The tables in this volume are sixty-nine in number, and each one is divided into a number of sections. Most of them are original work, and have been calculated or re-calculated by the compiler.

Pages 11 to 19 form a descriptive list of the tables, with notes on the use and application of the most important ones. Part I. is on Mathematics, Part II. on Mechanics, and Part III. on Physics, &c.

As a general rule, the English nomenclature and terminology has been adopted, but in the case of the aromatic hydrocarbons the German termination, -ol, has been adopted, *e.g.*, benzol, toluol, instead of benzene, toluene.

On the completion of the second volume an index of trades and industries will be added, showing what tables will be of most service to those engaged therein. The book gives evidence of a large amount of careful and laborious work, and will be of great use to scientific and practical men alike.

Bacterial Treatment of Crude Sewage. Fourth Report. By Dr. Clowes, F.I.C., &c. London: P. S. King and Son. 1902. Pp. 150.

The experiments described in this report are those which have been carried out on crude London sewage in settling-tanks and coke-beds at Barking and Crossness. The whole of the raw, unsettled sewage of the metropolis was formerly allowed to flow into the Thames without any previous treatment. The result was that the stream became insupportably foul, partly from the sewage mud itself, and partly through putrid changes occurring in the sewage matter dissolved in the water. Some time ago the main source of the nuisance was removed by screening and settling, and, finally, it was decided to purify the effluent further before it entered the river.

These experiments have been going on for four years, on a large scale, and the results arrived at are of great importance and worthy of the most serious consideration.

By the method of working which has been finally adopted after constant improvements and extensions, the raw sewage, screened from the coarser matter only, is pumped continuously into a settling-tank, at such a rate that it remains in the tank for about six hours before flowing into the coke-beds. In this tank the sludge settles, and a considerable proportion, up to 50 per cent, disappears through bacterial action. By the subsequent coke-bed treatment, the effluent is rendered sufficiently pure to support the life of fish, and to insure it against undergoing any offensive change, even in summer. Some of the principal points established by this experimental work are, that the sludge which settles out is reduced very considerably by bacterial action; that the coke-bed does not choke, and its purifying power undergoes steady improvement for some time; that the "bacterial effluent" never becomes offensive, and that the use of chemicals is quite unnecessary under any circumstances when this method of treatment is adopted.

The bulk of the report consists of tabulated results of different kinds, more than three-quarters being particulars of the bacteria beds, &c., at various centres throughout the country, either in permanent installations or in experimental form. This information has been placed in two

main divisions, one dealing with the bacteria (or coke) beds, and the other with the septic tanks.

To Londoners, however, the two sections dealing with the work carried out at the northern and southern outfalls, situated respectively at Barking and Crossness, is the most interesting.

An examination of the figures given for the amount of oxygen absorbed from permanganate, gives the clearest idea of the purification effected. To summarise a few of the figures only, we find that at the northern outfall works, the crude sewage absorbed an average of 12·711 parts of oxygen per 100,000; the effluent from the primary coarse coke-bed 3·213 parts, and the final effluent from the secondary fine bed only 1·726, during the year 1900. In another table we note that the sewage supplied to a coke-bed absorbed 9·076 parts of oxygen per 100,000, the effluent from the chemically treated and sedimented sewage 7·671 parts, and the effluent from the coke-bed 1·214 parts per 100,000. In the second case every effluent was putrescible, while in the latter case it was never so.

Dr. Clowes recommends, as a result of his prolonged experiments, that the London sewage should be treated by this method without delay. Of course, it would have to be done gradually, and the beneficent results would not be very apparent for some years. But we cannot find, in this report, any definite statement as to the extent of the works necessary to treat London's daily sewage, and this must be of necessity very great. The daily water supply may be taken at 200,000,000 gallons, and practically the whole of this finds its way back into the river through the sewers, to say nothing of the additional water, due to the rainfall over London's 400 square miles. Without going into further figures it appears as if the area required for coke-beds would be prohibitory, while the settling-tanks to allow of six hours' sedimentation would have to be of enormous extent.

CORRESPONDENCE.

IODINE AND BROMINE.

To the Editor of the Chemical News.

Sir,—In the *Journal of the Society of Chemical Industry* for November 29th last, I find that Dr. F. Mollwo Perkin has published a method for detecting iodine and bromine by means of the hypochlorites and sulphide of carbon.

It may interest many of your numerous readers that this method was made known by me in 1867—that is, thirty-five years ago. My note was published in the *Comptes Rendus*, under the title:—"Sur une Réaction trés simple pour reconnaître l'Iode at la Brome dans une même Solution." In this note I showed that the hypochlorites isolated, firstly, all the iodine, and afterwards the bromine, the first substance giving the well-known purple tint to the sulphide of carbon, which was afterwards changed to brownish yellow, or yellowish brown, on continution of the reaction, as the bromine was set free, and the colour due to iodine disappeared. I was enabled by this reaction to put in evidence, in the cold, both bromine and iodine in the sea-water at Ostend.—I am, &c.,

T. Lamb Phipson, Ph.D.

Diffusion of Arsenic in Nature.—F. Garrigou.—The author uses Bunsen's flame method for the detection of traces of arsenic, with the aid of the spectroscope, microscope, and the ordinary reactions. He finds arsenic in all rocks, in all crystalline minerals, in metallic fibres, in mineral waters, in drinking waters, in vegetable ash, and in all animal organisms. He concludes, therefore, that arsenic is one of the most widely distributed of all the metalloids.—*Comptes Rendus*, cxxxv., No. 24.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

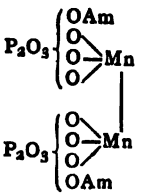
Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, del'Académie des Sciences. Vol. cxxxv., No. 24, December 15, 1902.

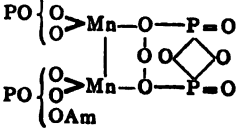
Aluminium Fluoride.—E. Baud.—Very little research has been done on the fluorine derivatives of aluminium since the work of Sainte-Claire Deville, and this is no doubt owing to the difficulty of analysing these compounds. The author prepares—(1) The hydrated fluoride of aluminium, and calculates its heat of formation; (2) the anhydrous fluoride, which is insoluble in all substances, even in concentrated hydrofluoric acid. In order to determine the heat of formation of this substance from known thermic constants, one essential number is missing—the heat of solution of the anhydrous fluoride or its heat of hydration, quantities impossible to measure with any degree of accuracy. Therefore his result, 498·98 cals., can only be considered as the nearest approximation.

Action of Boron Chloride on Ammonia Gas.—A. Joannis.—During the action of boron chloride on ammonia, the author finds that no gas is evolved, and it seems that the following action takes place:—Chloride of ammonium and boron amide being formed at −23°, $BoCl_3+15NH_3=3(NH_4Cl,3NH_3)+Bo(NH_2)_3$; and at 0°, $BoCl_3+6NH_3=3NH_4Cl+Bo(NH_2)_3$. This reaction is slow.

A Violet Ammoniacal Manganic Phosphate.—Ph. Barbier.—During the author's researches on the rose-coloured phosphate of Gmelin, he succeeded in preparing a new manganic phosphate of a much bluer and darker colour. He describes the preparation, and finds from analysis that it has the empirical formula $P_4O_{14}Mn_2,Am_2$, or the constitutional formula—



or it may be considered to be an ammoniaco-manganic diorthodimetaphosphate,—



Separation of the Alkalis from Manganese Peroxide.—H. Baubigny.—The author devises a simple method by which manganese peroxide may be separated from the alkalis and estimated quantitatively when in solution with these substances.

Oxybenzylphosphinic Acid.—C. Marie.—The author continues his researches on oxybenzylphosphinic acid, and prepares its silver salt, its methylic ether, and its benzoïl derivative.

A New Method of Chlorination of the Aromatic Carbides.—MM. Seyewetz and Biot.—Plumbico-ammoniacal chloride easily decomposes under the action of heat or reducing substances, giving lead chloride and ammonium chloride and chlorine. The authors employ this nascent chlorine to chlorinate the aromatic carbides, toluene, paraxylene, naphthalene, and anthracene.

MISCELLANEOUS.

Royal Institution.—On Tuesday next, January 13th, at 5 o'clock, Professor Macfadyen delivers the first of a course of six lectures at the Royal Institution on the "Physiology of Digestion"; on Thursday, Mr. A. J. Evans begins a course of three lectures, at the same hour, on "Pre-Phœnician Writing in Crete, and its Bearing on the History of the Alphabet"; and on Saturday, at 3 o'clock, Sir Frederick Bridge delivers the first of three lectures on the "Bi-Centenary of Samuel Pepys, his Musical Contemporaries, Criticisms, and Compositions" (with musical illustrations). The Friday evening Discourse on January 16th will be delivered by Professor Dewar on "Low Temperature Investigations"; on January 23rd by Dr. Tempest Anderson on "Recent Volcanic Eruptions"; and on January 30th by Professor W. E. Dalby on "Vibration Problems in Engineering Science."

Cathodic Polarisation and the Formation of Alloys.—A. Coehn.—The author has examined the formation of the alloy of two metals, MM', by the electrolytic deposition of the metal M on a cathode formed of the metal M', supposed to be less oxidisable (more noble) than M. He observes that in this case the potential of discharge of the metallic ions is diminished even when the two metals M and M' are solid. When the metal M is mercury, the liquid condition of which facilitates the diffusion of the metal deposited in the mass of the cathode, the phenomenon aquires a special distinctness. The tendency of different metals to form amalgams corresponds with the lowering of their potential of discharge on contact with a mercurial cathode; it decreases on passing from one term to another of the following series:—Zinc, cadmium, silver, copper, iron. When the metal M is hydrogen, we observe that palladium alone gives a potential of discharge lower than the point of reversible decomposition; thus, this metal is the only one with which hydrogen forms an alloy. The examination of the curves of decomposition of a solution of potash in the presence of different cathodes, and notably of a mercurial cathode, shows that the second point of cathodic decomposition corresponds with a complex ion of which the formula is apparently KH_3. From this point of view, ammonium behaves exactly like the alkaline metals, which removes one of the objections with regard to the metallic nature of ammonium.—*Zeit. Physik. Ch.*, vol. xxxviii., p. 609.

Synthesis of the Aromatic Alcohols from Formic Aldehyde.—R. Stoermer and K. Bern.—Formic aldehyde unites with the aromatic phenols and their derivatives, being substituted in the radical in the form of an alcoholic residue:—

$$CH_2O+C_6H_5{<}^{CHO}_{OH} = (5)CH_2OH{-}C_6H_3{<}^{CHO(1)}_{OH(2)}.$$

In this way, 10 grms. of salicylic aldehyde shaken up with 15 grms. of commercial formic aldehyde and 50 grms. of concentrated hydrochloric acid, gave 25 grms. of *aldehydo-oxybenzylic alcohol*, in the form of silky needles, fusible at 105°, soluble in acetone, alcohol, and ether, slightly soluble in benzene and chloroform; it gives a violet colouration with $FeCl_3$ in aqueous solution, and has no reducing properties. When treated with hydrochloric acid and absolute alcohol, this body gives the *chloride*, $C_6H_3(OH)(CHO)(CH_2Cl)$, fusible at 88°. The *oxime* of the alcohol fuses at 219°; it is a yellowish, crystalline powder, almost insoluble in the usual solvents, with the exception of alcohol; the *hydrazone* is a crystalline powder soluble in alcohol and fusible at 142°. The methyl ether, oxidised with $KMnO_4$ in alkaline solution, gives *methoxy-isophthalic acid*, from which we arrive at the constitution already given above. With the *o-homosalicylic aldehyde* we have obtained the alcohol $C_6H_2(CH_3)(CHO)(OH)(CH_2OH)$ 1.2.3 in the form of silky needles, soluble in the organic solvents. With salicylic acid very indefinite results were obtained. *o-Nitrophenol*, after boiling for six hours, gives the *oxy-nitrobenzylic alcohol* 1.2.4, in yellow needles, fusible at 97°, soluble in warm water and the usual solvents; at the same time a little *dinitrodioxydiphenylmethane* is formed. The *methylic ether* (1) fuses at 69°, it occurs in yellowish needles, soluble in boiling water; when oxidised by $KMnO_4$ it gives *m-nitroanisic acid*, fusible at 187°. The *chloride* (4) is in the form of yellow needles fusible at 72°, soluble in petroleum ether. The *o-chlorophenol* condenses with formic aldehyde in the cold, under the influence of hydrochloric acid gas, giving rise to the *chloride*, $C_6H_3Cl(OH)CH_2Cl$ 1.2, in crystals fusible at 93°, soluble in petroleum ether, transformed by boiling water into the corresponding *alcohol* in white needles, fusible at 123°, insoluble in petroleum ether and chloroform, but soluble in the other organic solvents.—*Berichte*, vol. xxxiv., p. 2455.

MEETINGS FOR THE WEEK.

TUESDAY, 13th.—Royal Institution, 5. "The Physiology of Digestion," by Prof. Allan Macfadyen, M.D.

WEDNESDAY, 14th.—Society of Arts, 8. "Industrial Trusts," by Prof. W. Smart, LL.D.

THURSDAY, 15th.—Royal Institution, 5. "Pre-Phœnician Writing in Crete, and its Bearings on the History of the Alphabet," by A. J. Evans, F.R.S.

FRIDAY, 16th.—Royal Institution, 9. "Low Temperature Investigations," by Prof. Dewar, F.R.S., &c.

SATURDAY, 17th.—Royal Institution, 3. "The Bi-centenary of Samuel Pepys—His Musical Contemporaries, Criticisms, and Compositions" (with Musical Illustrations), by Sir Frederick Bridge, M.V.O., Mus.Doc.

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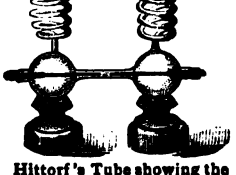

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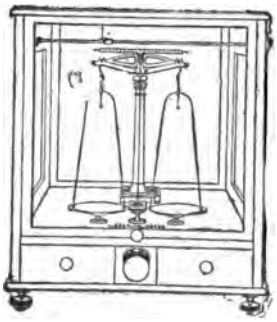

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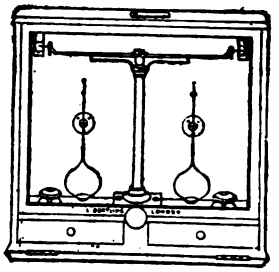

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THE CHEMICAL NEWS
AND
JOURNAL OF PHYSICAL SCIENCE.

Edited by SIR WILLIAM CROOKES, F.R.S.

Published every Friday. Price 4d. Annual Subscription post free, including Indices, £1.

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THE CHEMICAL NEWS

Vol. LXXXVII., No. 2251.

RADIUM, POLONIUM, AND ACTINIUM.*

By WM. J. HAMMER.

Since the discovery a few years ago by M. Henri Becquerel of the remarkable uranium radiations which have since been known by his name, such an amount of attention has been given by physicists to the study of radiant matter, and to speculative theories as to the constitution of matter, that it will probably be some time before our views can settle down and adjust themselves to the new phenomena which have been presented and are daily being brought to our notice.

Becquerel demonstrated that compounds of uranium, and especially the metal itself, prepared in the electric furnace, possessed very great radio-activity. Thorium compounds, especially thorium oxide, are next in activity, though far weaker.

Mdme. Sklodowska Curie and M. Pierre Curie noted that other elements were inferior to these, and that the compounds were inferior to the metals themselves. Bohemian pitchblende and two other compounds of uranium suggested to them by their greater radio-activity to that of pure uranium, that some new substance existed more active than uranium, and after most exhausting and painstaking investigations, they discovered a metal identical with bismuth in its chemical characteristics, and far more radio-active, which they named "polonium" after Poland, Mdme. Curie's fatherland. A further search resulted in the discovery of another new metal very similar to barium in its chemical properties, which they called "radium," which was even far more radio-active. This was followed by the discovery by M. A. Debierne of a third element, which he has named "actinium," which has chemical characteristics similar to thorium. It has as yet not been fully demonstrated that these three are actually new elements, as none has as yet been secured in a pure state. (See note 1 of Appendix).

It is not my purpose to-night to go fully into the investigations which have been made in these remarkable substances, with which many of you are doubtless familiar; but in view of the interest which radium has excited in the scientific world, and as there are probably few in this audience to-night who have had an opportunity of seeing this remarkable, and up to the present time exceedingly rare, substance, I take pleasure in presenting a small quantity for your consideration, which I have secured through the courtesy of Prof. Dayton C. Miller, who imported the same from Paris. The tiny sealed glass tube which I hold in my hand contains about 1 grm. of radium, which cost in Paris about ten dollars.

I have prepared a few notes regarding certain properties of radium, which I will read, and which I trust will prove of interest,† after which, if the lights are put out, I will pass around the room, and you can observe not only the illumination produced by the radium itself, but also the radio-activity of the cotton which I will wrap around the tube.

An extensive dealer in chemicals informed me recently that the treatment of 5000 tons of uranium residues would probably not result in the production of a kilo. of radium. The present market price in this country is 4.50 dollars per grm., or approximatelly 2000 dollars a pound.

M. and Mdme. Curie and H. Giesel have succeeded in further purifying radium, and I understand that a preparation will shortly be on the market here at the cost of 35 dollars per grm. The chloride and bromide of radium are the most brightly luminous compounds, but all the salts are more or less radio-active.

The radium preparation which I am able to show you to-night differs from such substances as sulphate of lime and various compounds of barium, calcium, strontium, uranium, &c., which possess the property of glowing in the dark when exposed for some time to light, or are rendered active by electrical or heat vibrations, in that radium requires no such exposure to become incandescent, but will glow for months and even years, and also has the property of causing other substances near it to become radio-active, and to retain this activity in many cases for a long period. Radium has been called a constant source of "X" or Röntgen rays and cathode rays.

H. Becquerel estimates that the energy expended by radium is a few C. G. S. units per second, and a few ten-millionths of a volt, and that at this rate the loss of matter would be about 1 milligrm. in a thousand years. He also finds that the radio-activity of radium is 900 times that of metallic uranium, while that of polonium is only 400 times. (See note 2 of Appendix).

He also calls attention to the facts demonstrated by M. and Mdme. Curie and himself, that radium radiations carry negative charges like cathode rays, and like cathode rays also can discharge electrified bodies at a distance as well as render the air gap between the plates of a condenser conducting, and the current passing susceptible of measurement by an electrometer. Also that many bodies when exposed to radium influences acquire temporarily the power of rendering the air conducting and of discharging electrified bodies, all of which afford proofs of the contention that there is in reality a continuous emission of energy by transport of matter from radio-active bodies; and H Becquerel estimates the speed with which these particles are radiated at half to two-thirds the speed of light.

These investigations have also shown that radium radiations are of three kinds, a portion deviable by a magnetic field, a portion non-deviable and readily absorbed, and a third weaker portion of diffused, non-deviable rays attributable partly to secondary rays.

M. and Mdme. Curie state that the deviable rays have the greater penetrative effect, but constitute but a small portion, and that the non-deviable rays, which constitute the major portion, do not travel further in the air than 7 c.m. from the source. According to M. Becquerel there seems to be no difference in the deviable qualities of radium rays in the air or in a vacuum. M. and Mdme. Curie show that polonium only emits non-deviable rays, and that these only travel 4 c.m. from the source in air.

Giesel's polonium, on the contrary, emits both deviable and non-deviable rays; and J. Elster states that magnetic deviation of polonium rays is produced in a vacuum, and seems to exceed deviation of radium rays under same conditions.

S. Meyer and E. R. Von Schweidler, in studying the absorption of radium rays, call attention by plotted curves to the fact that the first few hundredths of a millimetre are most effective in the absorption, and that it may be concluded that with radium rays, as in the case of Röntgen, uranium, and thorium rays, the radiations consist of a large number of rays of different nature.

According to M. and Mdme. Curie, radium rays act in many ways like light. They reduce silver salts, peroxide of iron, and bichromate of potash in presence of organic substances; but they also colour glass, porcelain, and white paper, and they transform greenish yellow platino-cyanide of barium into a brown variety.

Giesel had prepared platino-cyanide of barium with a

* A Paper read at the 150th Meeting of the American Institute of Electrical Engineers, New York and Chicago, January 3, 1902.

† Prepared from data given to the writer by Prof Curie, also data from compilations of E. E. Fournier D'Alba in *London Electrician*, *Science Abstracts* and other sources, these being abstracts of *Proceedings of Roy. Soc*, *Phil. Soc*, *Phys. Zeitschrift*, *Ann der Physik*, *Deutsche Phys Ges Verh.*, Chem. News, *Comptes Rendus. Soc. Francaise Phys. Bull.*, *Journ. de Physique*, &c.; see also. Prince Kropotkin on "Unsuspected Radiations," in *The Nineteenth Century*, December, 1900.

trace of radium. This spontaneously became brown, and it then polarised light like tourmaline. He also found that this coloured rock-salt just as cathode rays do, or the vapours of alkaline metals, and furthermore showed that radium salts, brought near the temples, or to the closed eyes, produced a sensation of light.

M. Becquerel, referring to the chemical action of radium rays, says that radium and uranium rays act upon silver gelatino-bromide, but produce no effect upon Daguerre plates, or upon photographic papers, and says that colourations of glass, porcelain, paper, and certain crystals, as well as the painful physiological effects, also belong to this class of phenomena. He also calls attention to the transformation of white into red phosphorus in twenty-four hours, the reduction of mercuric chloride in the presence of oxalic acid with the precipitation of calomel, and finally the destruction of the germinating power of seeds after long exposure.

Becquerel also shows that radium rays possess the same power as the electric spark, or the prolonged action of violet or ultra-violet rays, of restoring the phosphorescent properties under exposure to heat of a body deprived of them by over-heating.

O. Behrendsen found that by cooling radium in liquid air its radio-activity was reduced more than one-half. On heating again to a normal temperature, a slight increase of radio-activity was discovered, thus agreeing with the behaviour of phosphorescent bodies described by Lumière. (See note 3 of Appendix).

Curie and Debierne state that while all bodies become radio-active when placed in a closed vessel with solid salt of radio-active barium, this effect may be increased 40 times and made more regular by using the aqueous solution instead of the solid salt.

M. A. de Hemptemne, who discovered that gas which becomes luminous at a certain pressure under the influence of electrical vibrations becomes luminous at a higher pressure when exposed at the same time to "X" rays, also found that air which became luminous only at an exhaustion as low as 33 m.m., became luminous at a pressure of 44 m.m., brought into proximity with a radio-active substance, and at the same time the colour of the light changed from reddish violet to yellowish green.

Dr. C. Runge, the great German specialist, found that radium gave three distinct lines belonging to no other element. Demarçay had previously given these lines, together with some twelve others which he claimed to belong to radium, but thus far had not been proved to belong to radium. (See note 4 of Appendix).

Radium rays, like Röntgen or "X" rays, produce serious physiological effects. This was first demonstrated by Messrs. Walkoff and Giesel, the latter having kept on his hands for two hours a celluloid capsule containing radiferous barium bromide. The rays acting through the celluloid caused a light redness of the skin, and two or three weeks later inflammation set in, and the skin finally sloughed off.

M. Curie repeated Giesel's experiment upon himself, using radiferous barium chloride, acting through a thin sheath of gutta-percha, upon his hand. The activity of the substance was comparatively feeble, being about 5000 times that of metallic uranium. The rays left a red spot on the hand 6 c.m. square, which appeared like a burn, but gave no pain. In a few days the redness increased, and on the twentieth day crusts formed, ending with a sore which needed dressing. On the forty-second day the epidermis commenced to form on the edge, and fifty-two days after the action 1 square c.m. remained sore and of a greyish colour.

M. Becquerel, on carrying a small sealed tube containing a few decigrammes of very active radiferous barium chloride, the activity of which is 800,000 times that of uranium, underwent an experience of the same kind. The matter enclosed in the glass tube occupied a cylindrical volume of from 10 to 15 m.m. by 3 m.m. in diameter; the tube, wrapped in paper, was kept in a small paste-board box. On April 3 and 4, this box was placed several times in a corner of a vest pocket for a period, the total duration of which amounted to six hours. On April 13 it was perceived that the radiation through the tube, the box, and the clothes had produced a red spot on the skin, which became deeper as the time passed, marking in red the oblong form of the tube, and assuming an oval form 6 c.m. long by 4 c.m. wide. On April 24 the skin fell off; then the part most affected sank in, beginning to suppurate; oleo-calcareous dressings were applied to the sore for a month, the diseased tissues were removed, and on May 22, that is to say, forty-nine days after the action of the rays, the ulcer closed, leaving a scar which marked the placed of the tube.

"While care was being given to this burn," he says, "there appeared about May 15 a second oblong red spot opposite the other corner of the vest pocket in which the active matter had been placed. The exposure had been of short duration, an hour at most. Erythema now appeared, thirty-four days at least after the exciting action; inflammation developed, presenting the appearance of a superficial burn; on May 26 the skin began to fall off; on receiving the same care as the first, this burn appeared to be more rapidly cured.

"In the interval of these observations, on April, 10, 11, and 12, the same tube of active matter, enclosed in a lead tube, whose walls were about 5 m.m. thick, was kept for forty hours in another vest pocket, but has so far been attended with no physiological effect."

"It may be added that Mdme. Curie, by carrying in a small sealed tube a few centigrammes of the same very active matter which had caused the effects described above, had similar burns, although the small tube was enclosed in a thin metallic box. In particular, an exposure of less than half-an-hour produced at the end of fifteen days a red spot, resulting in a blister similar to a superficial scald. Fifteen days were required for the cure. These facts prove that the duration of the effects varies with the intensity of the active rays, and with the duration of the exciting action."

"Our hands have been also affected. There has been a general tendency to desquamation, the extremities of the fingers which have held the tubes or capsules containing active products become hard and very painful. In the case of one of us, the inflammation of the extremities of the fingers lasted about fifteen days, and indeed, after the falling off of the skin, the painful sensations have not yet completely passed away at the end of two months."

As illustrating the action of radium rays upon bacteria, E. Aschkinass and W. Caspari speak of exposing cultures of *Micrococcus prodigiosus* to a radium preparation, and state that the rays killed the germs very effectively in about three hours.

Appendix.

Since presenting the above paper on radium, I have visited Paris and had the pleasure of spending some time at Professor Curie's laboratory at the Ecole de Physique et de Chimie Industrielles, and Professor Curie has shown me some very interesting experiments and apparatus. I asked him to criticise the matter which I had prepared, and he very kindly gave me in writing the following notes which are numbered 1, 2, 3, and 4, and refer to the paragraphs in my notes which are similarly numbered.

Notes by Professor Curie.

1. It is well known to-day that radium is a new element characterised by a special spectrum. Radium has an atomic weight equal to 225. (Refer to the report given in the *Comptes Rendus* of July, 1902).

2. Radium, actinium, and polonium possess an activity which is a million times that of uranium.

3. I found, on the contrary, that radium emits exactly the same quantity of Becquerel rays when it is in the liquid air, as it does at the normal temperature of the atmosphere. The luminosity of the chloride of radium is

stronger in the liquid air than in the atmosphere at a normal temperature.

4. The spectrum of radium has been fully studied by Demarçay and the rays that he points out certainly belong to him.

I asked Prof. Curie whether there existed at the present time, or whether there has ever been made, a kilo. of radium, and was informed that during the past three years only between 500 and 600 grms. of radium had been manufactured, and that this included all grades of purity, and he also stated that radium, as a metal, did not exist, practically all which had been produced thus far being chloride of radium associated with barium; but he showed me a tiny tube of chemically pure chloride of radium, which he said was the only sample of it in a pure state that existed in the whole world. It was about the size of a buck shot and contained less than three one-hundredths of a grm., and on my inquiring its value I was told that it had any value that one wished to give it; but that 20,000 dollars could not buy it. It was with this sample of pure chloride of radium that M. Demarçay made his tests with the spectroscope, demonstrating that radium was a new element, for it showed no lines other than those characteristic of radium.

With this sample the atomic weight of radium was also determined to be 225, being considerably higher than that of barium, which is 157.

I saw at the laboratory of the Societé Centrale de Produits Chimiques, where the radium is manufactured, a similar tube of radium of a lower grade, there being still a considerable trace of barium in it, which tube had a value of 5000 dollars. Prof. Curie told me that he would not care to trust himself in a room with a kilo. of pure radium, as it would doubtless destroy his eyesight and burn all of the skin off his body, and probably kill him. He showed me the scars on his arm, one of which looked as if he had had a very serious ulcer, due to a radium burn, which, I understand, had taken fifty-two days to heal, and the other showed that the skin had been blistered and slightly scarred; the latter was caused by an exposure of but five minutes to some radium of very high activity; the more serious scar was due to an exposure of one hour and a-half to some radium of much lower radio-activity, approximately 5000. All of the radium manufactured in France is made under the supervision of Prof. Curie, and is tested and the samples classified by him. He informed me that whereas the best German product shows an activity of only 300 times the activity of uranium, the best commercial product which is at present on the market in France has 7000 times the activity of uranium, and this at present costs 100 dollars a grm. in Paris. Through the courtesy of Prof. Curie I was enabled to secure from the manufacturing laboratory a number of tubes of radium of varying degrees of radio-activity, and sample tubes of polonium of both bismuth-polonium metal and nitrate of bismuth and polonium, each possessing a radio-activity 300 times that of uranium, and tubes of pitchblende, uranium, uranium residues from which the radium is extracted, &c., I have also secured through the courtesy of M. Boulay, of the Societé Centrale, an interesting set of photographs made by radium rays.

Merck Products.—This well-known firm have recently issued a pamphlet giving further information, and the opinions of various medical men, concerning some of their recent preparations, many of which have been already noticed in the Chemical News. Among these we observe iodipin, dionine, bromipin, tannoform, and tropacocaine; the latter has been used in three manners, for eye diseases, in dentistry, and as an anæsthetic. It is of interest to see what a number of cases have been carefully examined in which one or the other of these, as yet, little-known drugs have been used; we trust this careful watching will continue, and that more of these products will be found to be both beneficial and trustworthy in their action.

NEW COLOUR REACTIONS WITH BORIC ACID.

By CHARLES E. CASSAL and HENRY GERRANS.

The authors find that an intense magenta-red colour is produced on treating solutions containing boric acid with curcumin—or ordinary turmeric itself—and oxalic acid, and drying the mixture on the water-bath. The colour is different to that obtained by the application of the ordinary turmeric test for boric acid, and the reaction is far more delicate, extremely minute quantities of boric acid being easily detected. The colour is practically permanent for several hours—not less than ten or twelve—and fades very gradually on long keeping. The colouring matter is readily soluble in alcohol and ether without alteration, but is destroyed by the addition of water in excess. On treatment with alkali an intense blue colour is obtained, which is different to that obtained on treating the "rose-red," colouring matter formed in the ordinary turmeric test, with alkali. In applying the test for the detection of free or combined boric acid in milk and other food products it is convenient as a rule to operate on an ash. The ash is treated with a few drops of (1) dilute hydrochloric acid, (2) saturated solution of oxalic acid, and (3) alcoholic solution of curcumin or turmeric, and the mixture dried on the water-bath and taken up with a little alcohol. In cases where the amount of boric acid is very small the substance, the ash of which is to be operated upon, should be made alkaline with solution of barium hydroxide prior to evaporation and incineration. Caustic potash and caustic soda and salts of potassium and sodium in *large* amounts interfere with the formation of the colouring matter.

The authors have successfully applied the test for the purpose of estimating boric acid.—*The British Food Journal*, Oct., 1902.

A COLORIMETRIC PROCESS FOR THE ESTIMATION OF BORIC ACID.

By CHARLES E. CASSAL and HENRY GERRANS.

The methods at present in use for the estimation of boric acid in articles of food are in many respects very unsatisfactory, and, owing to the want of delicacy of the reactions and processes involved, the amount of substance to be operated upon must always be large. The distillation method is lengthy, difficult to control, and uncertain—although the modifications introduced by various investigators have considerably improved the original process. The glycerin method introduced by R. T. Thomson, although capable of yielding fairly good results when the amounts of boric acid present lie between certain limits, and when the necessary precautions are *strictly* observed, is not reliable when somewhat small or unusually large amounts of boric acid have to be dealt with in such articles as milk, cream, and butter. In this process, when applied to these articles, the removal of the phosphates present is essential. With great care this can be effected—unless the amount of boric acid is very high, in which case separation of the phosphates is not completely attained—but there is always the danger of incomplete removal, and, on the other hand, the authors have also found that there is great danger of considerable loss of boric acid through the liability of the latter to be carried down with the calcium phosphate. There are also other objections which it is unnecessary to refer to at length.

The authors have carried out a large number of experiments with the object of devising a colorimetric process for the estimation of boric acid based upon the turmeric reaction. The "rose-red" substance produced by the action of boric acid on curcumin has been named

"Rosocyanin" by Schlumberger, who has shown that it can be obtained in the form of characteristic dark red crystals which have a greenish tint by reflected light. In the limited time at their disposal the authors have not been able to ascertain whether the magenta-red substance obtained by them in their oxalic acid and curcumin process, described in the previous note, is identical with Schlumberger's Rosocyanin, and they must leave the settlement of this matter to other investigators—with the observation that the colour obtained in the oxalic acid process is distinctly different to that which is formed in carrying out the ordinary turmeric test. Under the conditions to be subsequently described the intensity of the colour produced in the oxalic acid process is proportional to the amount of boric acid present, and the reaction is very delicate. The authors have therefore been able to base a method for the estimation of boric acid and borates in articles of food upon this reaction. The following is a description of the process as applied to milk, and this will serve as a convenient illustration of the method:—From 15 to 20 grms. of the sample are weighed in a platinum dish, treated with a saturated solution of barium hydroxide until the mixture is strongly alkaline, and evaporated to dryness in a paraffin bath at a temperature of about 105° C. The residue is well charred, broken up, made just acid with hydrochloric acid, and extracted with successive small quantities of hot water. The extracts are filtered into a 100 c.c. flask. The filter paper and its contents are transferred to the platinum dish, barium hydroxide solution is added to alkalinity, and the dish carefully heated in a Bunsen flame until the carbon has practically disappeared. The ash is dissolved in a little 25 per cent hydrochloric acid, the solution and washings transferred to the flask, and the whole made up to the 100 c.c. mark with water (Solution A). From 10 to 15 grms. of purified sand (obtained by igniting "silver sand," boiling this with 25 per cent hydrochloric acid, and thoroughly washing and drying) are placed in a porcelain dish, and mixed with 10 c.c. of the solution of the milk-ash (A). The use of such a medium as sand is essential in order to secure intimate and complete contact between the reacting substances at the drying point—which is the point of reaction. The mixture is made alkaline with barium hydroxide solution, and evaporated in the paraffin bath, the mass being stirred from time to time to ensure thorough incorporation. When dry the mixture is made just acid with 25 per cent hydrochloric acid and 2 c.c. of a saturated solution of oxalic acid, and 2 c.c. of an alcoholic solution of curcumin (1 grm. per litre), are well mixed in. The dish is placed in the paraffin bath, and is covered with a funnel, the stem of which is connected with a set of "potash bulbs" containing barium hydroxide solution, the bulbs being placed in a beaker containing cold water. Air is then gently aspirated through the apparatus until the mass in the dish is dry. An additional 1 c.c. of the curcumin solution is then added, well mixed with the sand, and the mixture again dried.

The colouring matter formed is now removed from the sand by treatment with successive quantities of alcohol or methylated spirit, the solutions obtained being filtered into a flask. The liquid in the "potash bulbs" is transferred to the sand in the porcelain dish and dried, care being taken that the mixture is alkaline with barium hydroxide. The mixture is treated as before with hydrochloric acid and the oxalic acid and curcumin solutions, and the processes of evaporation and alcoholic extraction repeated, the further yield of coloured alcohol being added to the alcohol solution first obtained. As a general rule this second treatment is sufficient to ensure that the whole of the boric acid present in the 10 c.c. of ash solution operated on has entered into the reaction. A standard colour is prepared by operating on 10 c.c. of a solution of boric acid of known strength (1 c.c. equal to 0·1 miligrm. of B_2O_3) in precisely the same manner, the coloured alcoholic solutions obtained from the standard being made up to 200 c.c. In producing the colour from the milk-ash solution the amount of the liquid should preferably be kept below 100 c.c. to allow of convenient dilution.

The coloured solution obtained from the milk-ash is diluted with alcohol or methylated spirit until the colour is of the same degree of intensity as that formed from the standard; and the amount of boric acid is arrived at by obvious calculation.

The colours are compared in two tubes of the same internal sectional diameter (about 1 c.m.) placed vertically against a white porcelain plate.

On comparing the two solutions it will occasionally be found that a certain amount of orange tint is exhibited by one or the other, due to the presence of curcumin in slight excess. When this is observed the tints must be made the same by the cautious addition of solution of curcumin to the solution which does not show the orange tint.

The results of a number of experiments made with known amounts of boric acid and borates show that the process is reliable and accurate.

According to the experience of the authors, free boric acid, when in solution, is far more easily lost by evaporation than appears to have been generally supposed. The use of the funnel and "potash bulbs" and the other precautions above mentioned are necessary to prevent small losses of boric acid.—*The British Food Journal*, Oct., 1902.

THE ACTION OF CARBON DIOXIDE ON THE BORATES OF BARIUM.*

By LOUIS CLEVELAND JONES.

In 1888 Morse and Burton described "A Method for the Separation and Determination of Boric Acid" (*Am. Chem. Journ.*, March, 1888, vol. x., pp. 154—158). I published an article in 1898 entitled "The Action of Carbon Dioxide on Soluble Borates" (*Am. Journ Sci.*, June, 1898, vol. v., pp. 442—446) an account of certain results not in accord with those of Morse and Burton. More recently (*Am. Chem. Journ.*, August, 1900, vol. xxiv.) Morse and Horn record at some length "preliminary experiments" made in an effort to substantiate the original analytical results of Morse and Burton.

I have waited for some time for the promised resumption of these experiments, and lest further silence be misunderstood, will show that the action of carbon dioxide and boric acid, in the presence of the one base—barium hydrate—both in the dry state and in solution, is that which I pointed out in my original paper, and, further, that these later experiments of Morse and Horn, correctly interpreted, completely substantiate this position.

The question is concerning the action of carbon dioxide gas upon a mixture containing boric acid and an excess of barium hydrate, viz., what part of the total barium is converted into carbonate, and, upon evaporation and ignition, how much, if any, of this barium carbonate is re-converted into borate? Indirectly, and stated differently, it is:—Can boric acid, when once separated, be brought into definite and weighable condition by the method recommended by Morse and Burton? (*loc. cit.*). Despite the title of the contribution of Morse and Burton, Morse and Horn now regard the separation of the boric acid "as the most, and in fact the only, important feature of their contribution."

The following is the entire description of that part of the process relating to the determination of the boric acid as originally given by Morse and Burton:—"The quantity of the dilute barium hydroxide solution" (about 25 c.c.) "which is equivalent to 25 c.c. of the standard sulphuric acid" (N/10) "is run into the flask, and the apparatus attached to a filter-pump." This is done preparatory to

* Contribution from the Kent Chemical Laboratory of Yale University. From the *American Journal of Science*, vol. xiv., p. 49

receiving the alcoholic solution of boric acid—a little over 75 c.c. "*Finally, the excess of the barium hydroxide is precipitated by passing into it a current of carbon dioxide; the contents of the flask are transferred to a platinum dish, evaporated to dryness, and heated to a constant weight over a triple burner.*"*

In my original article I made three claims:—First, that the metaborate of barium may be decomposed by gaseous carbon dioxide; second, that the boric acid thus "liberated" may be lost by volatilisation; third, that the metaborate of barium and the carbonate may interact at high temperatures with the loss of carbon dioxide. These facts preclude the use of the method described by Morse and Burton for the determination of boric acid. The more recent experiments of Morse and Horn not only substantiate these facts, but disclose a fourth objection to the use of this method for its original purpose, viz., the difficult dehydration of the metaborate of barium, concerning a mixture of which with barium carbonate, Morse and Burton originally said that it "being neither markedly hygroscopic nor capable of absorbing carbon dioxide, can be brought to a constant weight more readily than one containing oxide of calcium or magnesium."

The Decomposition of Barium Metaborate.—That barium metaborate may be decomposed by carbon dioxide in aqueous solution, is proved by my original experiments; and now is corroborated by those of Morse and Horn. These authors, however, urge that, in alcoholic solutions —78 per cent—the boric acid would be in the form of metaborate of barium only, and this should be unattacked to the extent of its insolubility. To test this point directly, carbon dioxide was passed into equivalent parts of barium hydrate and boric acid in 78 per cent alcoholic solution. The precipitate gave abundant evidence of the presence of carbonate, showing decomposition of the metaborate. The extent of this decomposition was determined quantitatively by determining the carbon dioxide in another similar precipitate. Barium hydrate and an excess of boric acid in a mixture consisting of 73 per cent alcohol, were treated in the cold for three hours with carbon dioxide. The precipitate was filtered, washed, and analysed for carbon dioxide with the following result:—

$Ba(OH)_2$ taken, 0·7883 grm.; B_2O_3 taken, 0·3576 grm.; excess B_2O_3, 0·0357 grm.; CO_2 found, 0·2042 grm.; CO_2 in total barium carbonate, 0·2024 grm.

Evidently the metaborate of barium in alcohol was completely decomposed by carbon dioxide and the boric acid *liberated*.

Another experiment was made as above, except that equivalents were taken, and the treatment with carbon dioxide was discontinued after thirty minutes. After stopping the flow of carbon dioxide, the mixture was boiled for three minutes, to remove any excess of gas. The precipitate was filtered, washed with 150 c.c. of hot water, and analysed for carbon dioxide. The result was as follows:—

$Ba(OH)_2$ taken, 0·4379 grm.; B_2O_3 taken, 0·1788 grm.; alcohol, 76 per cent; CO_2 found, 0·1135 grm.; CO_2 in total barium carbonate, 0·1124 grm.

Upon evaporating to small volume the filtrate from this experiment, boric acid in abundance crystallised from the solution. Under these conditions, then, well within the limits of the recommendations of the Morse and Burton process, it is clear that barium metaborate is completely converted into carbonate with consequent *liberation* of boric acid, and that alcoholic solutions in no way prevent the action.

It might be argued that, in an evaporating mixture containing barium carbonate and boric acid in 78 per cent solution, the reaction would be reversed after the volatilisation of the alcohol and the solutions became more concentrated. Indeed, Morse and Horn used this explanation (p. 110). To test this hypothesis, equivalent parts of barium hydrate and boric acid in alcohol were treated with carbon dioxide for two hours, the mixture evaporated to dryness, and the carbon dioxide remaining in the dry residue determined. The following results were obtained:—

$Ba(OH)_2$ taken, 0·4554 grm.; B_2O_3 taken, 0·1860 grm.; alcohol, 82 per cent; CO_2 found, 0·1018 grm.; CO_2 in total barium carbonate, 0·1169. This shows that even with the very strong alcoholic solution, which was used by mistake, about 90 per cent of the metaborate was converted into carbonate and remained as carbonate after bringing to dryness.

To demonstrate, in another way, the presence of boric acid after the treatment recommended by Morse and Burton, I have used the methyl alcohol flame-test. Equivalents of barium hydrate and boric acid (I have used the word equivalents repeatedly, meaning quantities to form exactly the most important salt under discussion, viz., metaborate) were evaporated to dryness, methyl alcohol added and burned without getting the slightest indication of free boric acid. Again, equivalents of barium hydrate and boric acid were treated in alcoholic solution with carbon dioxide, the ethyl alcohol and water removed by evaporation, and methyl alcohol applied and burned with unmistakable indications of free boric acid—burning with a solid green flame.

Since free boric acid does not decompose barium carbonate upon evaporation, the question arises as to what is the temperature required to bring about this decomposition. The following experiment throws some light upon this point: Finely divided anhydrous boric acid (0·1925 grm.) and barium carbonate (0·5177 grm.) were mixed in a platinum crucible moistened with water and allowed to stand sixty hours. The contents of the crucible were then dried on a steam bath and afterwards heated for thirty minutes in an air bath at 350° C. The carbon dioxide remaining in the mixture was determined and found to be 0·0844 grm. Total CO_2 in $BaCO_3$ taken, 0·1154 grm.; CO_2 liberated by B_2O_3, 0·310 grm.; CO_2 displaceable with formation of $Ba_2OB_2O_2$ by B_2O_3 taken, 0·1210 grm. Therefore, 74·38 per cent of the boric acid taken, if still unvolatilised, remains uncombined—at 350° C.

From the foregoing experiments, then, it is obvious that carbon dioxide decomposes the metaborate of barium in either aqueous or alcoholic solutions, and a portion, at least, of this boric acid liberated not only remains uncombined after evaporating to dryness, but even upon heating to a high temperature.

Loss of Boric Acid by Volatilisation.—It is scarcely conceivable that a mixture of boric acid and barium carbonate in water should not lose an appreciable amount of boric acid on evaporation. Morse and Horn have found a detectable loss of boric acid from treating aqueous mixtures of barium hydrate and boric acid with carbon dioxide and evaporating. The carbon dioxide was stopped shortly after the alkaline colouration with phenolphthalein was destroyed. The quantity found by them is given, and varies from 0·0001 grm. to 0·00016 grm.; in one instance exactly 0·00012 on 0·0633 grm. of total boric acid present—

$$\left\{\frac{0·00636+0·02538}{2}\times 13·77\right\}\div 3·448=0·0633 \text{ grm.}$$

The decrease in weight should be even more noticeable in the presence of alcohol, though Morse and Horn did not detect more than 0·0040 grm. B_2O_3 [(1/14200)×50= 0·0040], and this only when the concentration of alcohol arose above 92 per cent. Amounts below one part in 14,200 they were not able to discover.

The actual amount of boric acid volatilised on evaporating such mixtures to dryness is, of course, small, but certainly appreciable. Furthermore, under the analytical conditions described by Morse and Burton, the greater loss of boric acid doubtless occurs with the escape of water of combination between the temperature 100° C,

* The italics, as in other quotations to follow, are mine.—L. C. J.

and that at which the boric acid completely replaces its equivalent of carbon dioxide in barium carbonate. This temperature I have shown by experiment to be at least above 350° C. On the other hand, as was shown in my original paper, under extreme conditions, by the use of methyl alcohol and a continuous current of carbon dioxide, it is possible to volatilise all the boric acid from a mixture of barium hydrate and barium metaborate.

The Interaction at High Temperatures of the Carbonates and Borates of Barium.—I have shown that the treatment recommended by Morse and Burton may result in a mixture containing barium carbonate and barium metaborate, or barium carbonate, barium metaborate, and boric acid, or, indeed, barium carbonate and *free* boric acid. Of these compounds, both the barium metaborate and boric acid retain water considerably beyond 100° C.

Morse and Burton assumed that they had, after evaporation, a mixture containing only barium carbonate and barium metaborate. Morse and Horn explain it as follows: "It may be urged that even if Morse and Burton had the metaborate in insoluble condition, and it had been sensibly attacked during the treatment with carbon dioxide, nevertheless, in the subsequent attempt to heat the dried ites due to constant weight, the metaborate must have attacked the carbonate. It has *since* then come to light that *some caution* must be exercised in this part of the manipulation. In the original description of the method, it was simply stated that the residue was heated to constant weight over a triple burner. The practice then, and on the few occasions when the process has since been used, was to hold the burner in the hand and rapidly play the flame over the platinum dish in order to secure as uniform a temperature of the contents as possible. The object in using a triple burner was not to obtain a *very high temperature*, which is not necessary, but, rather, to employ a flame large enough to keep the whole dish hot. No difficulty was experienced, when the heating was conducted in this manner, in *quickly* obtaining *constant and correct weights*. Nevertheless, it must be admitted, the authors of the method did not at that time suppose that the temperature at which the meta salt will attack the carbonate is so low as it has since been found to be. The temperatures employed by Jones were evidently *far* above those to which Morse and Burton heated their mixtures of metaborate and carbonate."

The use of a triple burner to secure gentle and uniform heating is unusual. Indeed, Morse and Horne used it in experiment XIV. for a quite different purpose, *i.e.*, to secure a temperature which decomposed the carbonate and borate mixture present. That the temperatures employed by me in my original experiments were *not* "*far* above those" used by Morse and Burton, can be answered best by the words of Morse and Horn: "*At a full red heat* the meta salt attacks the carbonate with expulsion of carbon dioxide" (page 130). "The temperature at which a mixture of the metaborate and the carbonate of barium is stable, and which is still sufficiently high to insure the dehydration of the former, *appears* to be *just* under a red heat" (page 130). Morse and Horn do not, however, produce any evidence to show that the meta salt is dehydrated below red heat. In fact, their experimental evidence points the other way: "The experiment of heating the material, after treatment with carbon dioxide, until the weight fell below that calculated for a mixture of metaborate and carbonate, and then of exposing it in the air until the weight became very nearly constant, and finally, of removing the slight excess of weight by placing the material over calcium chloride or sulphuric acid, was many times repeated, and always with a satisfactory degree of success except in two cases. In these it was *suspected* that, *while some portions of the material had been heated high enough to decompose the carbonate, other portions had not reached the temperature required for the complete dehydration of the metaborate*; for it was observed that the weights gained in the air on these occasions far exceeded the calculated deficits." Evidently, the temperatures at which decomposition of the carbonate and dehydration of the metaborate of barium takes place, cannot be *far* apart when both processes are going on in the same crucible.

I quote further (page 133): "In general, it was found difficult, by heating in our bath, to bring the too great initial weight of the material down to that calculated for a mixture of metaborate and carbonate, though in one case (No. XXX.) this was accomplished by heating in the bath for three hours over three burners. The temperature on this occasion, however, rose so high that the thermometer was removed." The thermometer used registered as high as 550° C.

The conditions described above can only be accounted for in two ways, viz: (1) The metaborate has been decomposed by carbonate dioxide, though this treatment was stopped five minutes after the disappearance of alkalinity with phenolphthalein—and the barium carbonate has not at this temperature been decomposed; or (2) the metaborate still contains water.

A combination of both these explanations, doubtless, more nearly expresses the truth. Morse and Horn, however (page 134), seem to prefer the latter explanation. "This," they say (*i.e.*, the behaviour of the ignited mixture in experiment XXX.), "led us to *suspect* that the temperature at which complete dehydration occurs and that at which the metaborate begins to attack the carbonate cannot be very *far* apart."

The experiments made by Morse and Horn in an effort to show how these mixtures can be "quickly" brought to "constant and correct weights" are interesting, but not conclusive. They proposed (page 119) "to determine also the effect of exposing these mixtures, after heating, in an atmosphere containing carbon dioxide," with the object of finding "the temperature at which it was presumed a mixture of the metaborate and the carbonate of barium is stable, or rather the temperature at which it becomes stable." All these experiments, and those in which the mixtures were exposed to the air and dried in a desiccator, prove nothing; in fact, Morse and Horn only draw inferences from them (page 134): "From this it appears probable that the more basic borate which is formed at high temperatures, is decomposed at ordinary temperatures by the carbon dioxide of the air and re-converted into the borate and carbonate. A similar absorption of carbon dioxide takes place when material whose weight has been reduced below the normal amount is re-heated in the bath at temperatures under 500° C. From this it is *inferred* that normal weights could be *quickly* obtained by first heating to a high temperature and then at a lower one, but we have not yet tried the experiment."

Those final and satisfactory weights which are sometimes obtained may be due to the presence of an excess of carbon dioxide or water, or both, in an amount sufficient to replace any boric acid volatilised in evaporation and especially with the water of hydration. That Morse and Horn did have present in these experiments at the beginning of evaporation some free boric acid—or, if it is preferred, a more acid borate—and a corresponding increase in the amount of carbonate, is certain, because in all these experiments of which the results are recorded, carbon dioxide was passed for not less than fifteen minutes, or when phenolphthalein was used as an indicator, usually for five minutes after the disappearance of the alkaline reaction.

In my original paper I suggested the use of phenolphthalein to prevent too great an excess of carbon dioxide and corresponding decomposition of the metaborate. In a recent experiment I have tested the action of a metaborate in alcoholic solution upon this indicator, and find that exact equivalents of barium hydrate and boric acid in 78 per cent alcohol give a decided alkaline reaction, and that this alkaline colouration disappears only when about 36 per cent more boric acid is added. It is clear that phenolphthalein gives indication, not when the excess of barium hydrate is converted into carbonate, but at a point

considerably beyond. Morse and Horn, then, were working with barium carbonate and an acid borate, and in many cases, most certainly, with barium carbonate and free boric acid.

If by accident—and I see no other way of doing it—the action of carbon dioxide is stopped just when the excess of barium hydrate has been converted into carbonate, still nothing is gained; for the experiments of Morse and Horn—if they show anything—make it clear that even these salts cannot be weighed with safety.

These experiments leave nothing more to be done to prove the impossibility of bringing to definite and constant weights the mixtures resulting from the method described by Morse and Burton. Furthermore, in the promised forthcoming continuation of this study by Morse and Horn, I see no possibility of any other deduction.

In conclusion, then, I reiterate :—

First.—Carbon dioxide decomposes the metaborate of barium in either aqueous or alcoholic solutions.

Second.—The boric acid liberated may in part escape during evaporation to dryness and especially before reaching that temperature at which it has completely re-combined with the barium, replacing carbon dioxide.

Third.—A mixture, containing barium carbonate and hydrated boric acid, or barium carbonate with the hydrated metaborate and boric acid, or even barium carbonate and hydrated metaborate, cannot with safety be brought to definite composition for weighing.

NITRITES IN SUGAR-WORKS PRODUCTS.

By MM. ANDRLIK and STANER.

Up to the present time no quantitative determinations of nitrites in sugar-works products have been published; it appears, however, as if these bodies may be of some importance.

We have made use of Pellet's method, which consists of decomposing the nitrites in aqueous solution by acetic acid and the double chloride of iron and ammonium. Under these conditions the nitrates are not attacked, and the nitrogen evolved comes entirely from the nitrites. We have confined our estimations to the products which might be supposed to be the richest in nitrites and nitrates; that is, to molasses and syrups, and occasionally to the "boiling."

No.	Acidity in c.c. of normal potash.	Nitrous acid.	Nitric acid.
		M.grms.	M.grms.
1. Bohemian molasses.. ..	Alkaline	7	36
2. ,, ,, ...	,,	4	32
3. ,, ,, ...	,,	5	28
4. ,, ,, ...	,,	4	21
5. ,, ,, ...	,,	.5	38
6. ,, ,, ...	,,	9	56
7. ,, ,, ...	,,	10	29
8. Hungarian "boiling" ..	1·5	9	39
9. ,, ,, ...	4·0	20	28
10. ,, ,, ...	6·5	32	74
11. Italian syrup	10·7	41	59
12. Hungarian syrup	10·5	not estimated	490

The three latter samples frothed strongly, while the remainder showed no such phenomenon.

The amounts of nitrous or nitric acids in the Bohemian products varied from 0·004 to 0·01 per cent, while they increased considerably for the Hungarian and Italian products, as did also the acidity, and then the frothiness was produced.

When considering this richness in nitrous or nitric nitrogen and the tendency to froth, and the fact that oxides of nitrogen are sometimes given off by the frothy fermentation of syrups, we are led to the conclusion that the presence of large quantities of nitrites ought to facilitate or perhaps bring on the frothy fermentations.

Claasen identified two kinds of frothy fermentation—according as the froth occurred simply on the surface, or throughout the mass of the syrup; and in this latter case we observe that oxygen is absorbed while carbonic acid is given off; he considers that we have to do with a phenomenon of a chemical order, decomposition by oxidation.

Von Lippmann has even observed the froth in the alkaline products, and he attributes it to a phenomenon of a chemical order, with the absorption of oxygen; this opinion is shared by Herzfeld and by us. All syrups and molasses, without exception, contain a large number of ferments, and we cannot well understand these developing in very viscous liquids containing 90 per cent of dry material.

Perhaps this development is the initial cause of the phenomenon by modifying the composition of the juices or the syrups; but it is very probable that the froths are due more especially to a chemical decomposition.

We have observed in the gases given off by frothy syrups both carbonic acid and binoxide of nitrogen, and this same mixture has been obtained by heating the syrup; acetic acid has also been found. A boiling was sampled while frothing, and it was dissolved in water containing a little acetic acid; on boiling, 100 grms. of the original "boiling" gave 170 c.c. of gas, consisting of 52·3 per cent CO_2 and 32·3 per cent of NO. The water over which the gas was collected was strongly acid.

Samples of syrups, "boiling," and residues examined, contained the following, per cent :—

	I.	II.	III.
Dry matter	93·46	87·72	87·42
Polarisation	71·20	54·40	48·00
Saccharose	71·06	Omitted	51·70
Invert sugar (m.grms. of Cu)	0·045	0·51	0·40
Ash	8·23	9·33	13·37
Actual purity	76·20	62·0	59 00
Total nitrogen..	1·49	1·85	2·22
Nitric nitrogen..	0·074	0 059	0·491
Nitrous acid	0·032	0·041	Omitted
Acidity in c.c. of normal KOH	6 0	10·7	10·0

These three products are all frothy, and are distinguished by a strong acidity and a rather high proportion of nitrous nitrogen. On the other hand, they show a certain amount of caramelisation, so that sub-acetate of lead will not decolourise them; finally, these syrups are rich in nitrogen.

We can get the froth in an entirely normal molasses by adding a nitrite and acidulating with lactic acid; a gaseous mixture is given off, analogous to that observed by heating a boiling with acetic acid, since in 100 volumes we find 54·3 CO_2 and 38 NO. The swelling up of the mass is only temporary, and the froth simply remains on the surface after the gas has been given off.

Thus it seems as if we ought to look upon the froth as being produced, not only by an evolution of carbonic acid gas, but also by the binoxide of nitrogen from the decomposition of the nitrites.

These abnormal froths must be attributed to the composition of the beetroots, these being rich in nitrogenous matter through having grown on a soil rich in nitrates and having undergone, after harvesting, a transformation of part of these in nitrates into nitrites. For the juices containing nitrites to give a froth they must also be able to lose their alkalinity, and become acid during the concentration of the boiling.

This is what happens to the juices rich in acids, and to those obtained from beetroots which have been overheated or damaged; these same juices contain invert sugar, and by the decomposition of this latter they produce organic acids which saturate the remaining alkalinity. Thus the alkalinity disappears in the boiling, and the destruction of the invert sugar continues; the boiling becomes acid, giving rise to a fresh inversion. On the

other hand, the nitrates can be reduced to the state of nitrites by bacteriological action, either in the damaged beetroots, in the diffusion juices, or in the syrups. Thus we get an acid boiling, the acidity decomposes the nitrites, and the froth is produced.—*Zuck. Ind. in Bohmen.*, 1902, p. 229.

THE ACTION OF CHROMIC ACID ON PEROXIDE OF HYDROGEN.

By A. BACH.

With the object of obtaining more precise information as to the mechanism of the action of oxidising agents on peroxide of hydrogen, I have endeavoured to ascertain more closely, from the quantitative point of view, the manner in which chromic acid behaves with this body. In this paper I propose describing briefly the results I have obtained.

Chromic acid behaves differently with peroxide of hydrogen according as the reaction takes place in the absence or presence of an acid. In the former case chromic acid is liable to decompose limited quantities of the peroxide—with the formation of a brownish-red intermediate product*—without itself being reduced.

In the latter case the reaction takes place in such a manner that after the formation of the long-known blue, unstable product, there is a definite simultaneous reduction of both the chromic acid and the peroxide of hydrogen, with the disengagement of oxygen and the formation of a salt of chromic oxide.

Action of Chromic Acid on Peroxide of Hydrogen in the Absence of an Acid.

When we cause pure chromic acid to act on pure peroxide of hydrogen free from acid, the mixture takes a brownish-red colouration, which gradually disappears, with the disengagement of oxygen, giving place to the original colour of the chromic acid.

Quantitative experiments were carried out in the following manner:—

By decomposing an accurately weighed quantity of chemically pure bichromate of potassium by the exactly necessary amount of decinormal sulphuric acid, I obtained a solution of chromic acid containing 19·2 grms. of disposable oxygen in 10 c.c. of the solution. By means of this chromic solution I determined the exact strength of a solution of hyposulphite of soda, which, in its turn, served for estimating the strength of a solution of iodine. On the other hand, I prepared a solution of chemically pure peroxide of hydrogen, containing 5 milligrms. of active oxygen per c.c. After having introduced into the decomposition vessel of the apparatus previously described, various but accurately measured quantities of the peroxide solution, 10 c.c. of the chromic solution were added by means of a burette, and the vessel was shaken until there was no more gas given off. The volume of the liberated oxygen was noted, and the liquid resulting from the reaction was transferred to a foot glass, with the help of 150 c.c. of water, and the remaining chromic acid estimated iodometrically.

In this manner the following results were obtained:—

Disposable oxygen in the chromic solution.	Active oxygen in the peroxidised solution.	Oxygen given off.	Disposable oxygen in the solution resulting from the reaction.
M.grms.	M.grms.	M.grms.	M.grms.
19·2	5·0	4·62	18·81
19·2	10·0	9·20	18·40
19·2	15·0	14·17	18·63
19·2	20·0	19·46	18·76

* The formation of this intermediate product has been already observed by M. Berthelot, *Comptes Rendus*, vol. cviii., p. 477.

It can be seen from these figures that, in the action of chromic acid on peroxide of hydrogen in the absence of acid, an amount of oxygen is given off corresponding exactly with the active oxygen in the peroxide used.

Action of Chromic Acid on Peroxide of Hydrogen in the Presence of Acids.

Baumann (*Zeitschr. f. Angew. Ch.*, 1891, p. 135) has suggested a gasometric method for the estimation of chromic acid, based on the observation that, in the action of chromic acid on peroxide of hydrogen in the presence of sulphuric acid, 4 atoms of oxygen are given off for each molecule of chromic acid reduced. According to Marchlewski (*Zeitschr. f. Ang. Ch.*, 1891, p. 392) this observation is not altogether correct, inasmuch as in this reaction there is always a little less oxygen given off than is to be expected by Baumann's method. My personal experiments have confirmed Marchlewski's assertion, and show that for each molecule of chromic acid reduced there are 3·5 atoms of oxygen liberated.

These experiments were carried out with the same solutions and under the same conditions as those above, with this difference, that 5 c.c. of normal sulphuric acid were poured into the decomposition vessel at the same time as the solution of peroxide of hydrogen. The results obtained are given in the following table:—

Disposable oxygen in the chromic solution.	Active oxygen in the solution of peroxide.	Oxygen given off.	Chromic oxygen engaged in the reaction.		Proportion $CrO_3:H_2O_2$.
			Gasometrically.	Iodometrically.	
M.grms.	M.grms.	M.grms.	M.grms.	M.grms.	
19·2	5·0	8·56	3·56	3·70	1 : 2·10
19·2	10·0	16·66	6·66	6·84	1 : 2·25
19·2	15·0	25·98	10·98	10·98	1 : 2·09
19·2	20·0	34·34	14·34	14·34	1 : 2·08
19·2	25·0	43·34	18·34	18·34	1 : 2·04
19·2	30·0	44·88	19·20 m.grms. (excess of peroxide).		1 : 2·00

The chromic oxygen engaged in the reaction was determined, on the one hand, by the difference between the oxygen given off and the active oxygen contained in the peroxide, and, on the other hand, by the iodometric method, as has been explained above. As soon as the amount of peroxide of hydrogen used exceeded that corresponding to the proportion $CrO_3 : H_2O_2 = 1 : 2$, the presence of peroxide in excess was detected in the product of the reaction by means of permanganate of potash. In this latter case the peroxide oxygen entering into the reaction was determined by the difference between the oxygen given off and the chromic oxygen used.

We see by this table that, in the action of chromic acid on peroxide of hydrogen in the presence of sulphuric acid, there is a simultaneous reduction of the two substances with the liberation of oxygen.

For each molecule of chromic acid 2 molecules of peroxide of hydrogen come into the reaction. Thus, the reaction ought to be expressed by the following equation:—

$$4CrO_3 + 8H_2O_2 + 6H_2SO_4 = 2[Cr_2(SO_4)_3] + 7O_2 + 14H_2O.$$

It is easy to show the quantitative side of the reaction between chromic acid and peroxide of hydrogen by the following simple gasometric experiment:—

We decompose a known quantity of any solution of peroxide of hydrogen, by means of an acid solution of permanganate, and measure the amount of oxygen liberated. Now, if we treat the same quantities of the solution of peroxide with chromic acid in excess, once in the absence of acid and once in the presence of sulphuric acid, we obtain in the first case exactly one-half, and in the second case seven-eighths of the amount of oxygen given off by the peroxide under the action of the permanganate. According to the difference it is easy to calculate the proportion $CrO_3 : H_2O_2$.

For example:—

	C.c. of oxygen.
5 c.c. of a solution of peroxide of hydrogen liberated with permanganate	36·8
5 c.c. of the same solution gave, with CrO_3 in the presence of sulphuric acid	31·4
5 c.c. of the same solution gave, with CrO_3, in the absence of acid	18·2
Chromic oxygen entering into the reaction ..	13·2

Ratio $CrO_3 : H_2O_2 = (13{\cdot}2 \times 2) : (18{\cdot}2 \times 3) = 1 : 2{\cdot}09$.

Theoretical Considerations.

The manner in which chromic acid behaves with peroxide of hydrogen furnishes some important points for consideration with regard to the hypotheses relating to the mechanism of the action of oxidising agents on peroxide of hydrogen. I will only speak here of the hypotheses of Traube and of Berthelot.

We know that, according to Traube, the hydrogen and oxygen would be only feebly combined in peroxide of hydrogen. Consequently, when oxidising agents are caused to react on this substance, its hydrogen is burnt to form water, and its oxygen is liberated integrally in the free state.

According to this hypothesis, in the action of chromic acid on peroxide of hydrogen, the former should be reduced to the state of chromic oxide, and the latter should give off the whole of its oxygen in the free state. Now, we have seen that in the absence of sulphuric acid, the chromic acid is not reduced at all, and that the peroxide only gives off half its oxygen; that is to say, only its *active* oxygen.

In the presence of sulphuric acid there is certainly a reduction of the chromic acid, but the amount of this acid reduced is less than that necessary for the oxidation of the hydrogen from the peroxide of hydrogen decomposed. According to Traube's hypothesis, the reaction between the chromic acid and the peroxide of hydrogen in the presence of sulphuric acid should take place according to the equation:—

$$2CrO_3 + 3H_2O_2 + 3H_2SO_4 = Cr_2(SO_4)_3 + 3O_2 + 6H_2O.$$

But we have seen that in reality it corresponds with the equation:—

$$4CrO_3 + 8H_2O_2 + 6H_2SO_4 = 2[Cr_3(SO_4)_3] + 7O_2 + 14H_2O.$$

Thus, there is *less* chromic acid reduced and *more* oxygen liberated than there should be according to Traube's hypothesis. The facts which have just been stated seem, therefore, to completely dispose of this hypothesis.

But M. Berthelot's hypothesis also is not compatible with these facts. If we try to explain the reduction of the chromic acid in the presence of acids, by the intermediate formation of a trioxide of hydrogen, we are obliged to admit that of the 8 molecules of peroxide of hydrogen that enter into the reaction, 6 unite with the 6 atoms of disposable oxygen of the chromic acid, to form the hypothetical trioxide of hydrogen, while the 2 remaining molecules of peroxide are reduced in some other manner, which appears to me to be very unlikely.

The indisputable formation of a superoxygenated derivative of chromium during the action of chromic acid on peroxide of hydrogen enables us, in my opinion, to explain the decomposition of the peroxide by the metallic oxides more or less rich in oxygen, in a very simple manner. We can admit, in fact, that there is formed first of all, as an intermediate product, a superoxygenated derivative, not of hydrogen but of the metal employed.

In some cases (U, V, Ti, Mo, W, Nb, Ta) this intermediate product is relatively stable and can be isolated; in other cases, such as Cr, it is only slightly stable, but its characteristic colouration places its formation beyond all possible doubt; in other cases again (Ag, Hg, Pt, Pb, Mn), the formation of the intermediate product is not made manifest by any outward sign.

The formation of this kind of superoxygenated products seems to play the same part in the so-called catalytic decomposition of peroxide of hydrogen as in the decomposition according to a definite equation.

These processes can be explained in the following manner:—

In both cases the same intermediate product is formed by the addition of the peroxide of hydrogen to the oxygenated metallic compound used.

In the absence of acids, the superoxygenated intermediate compound decomposes in such a manner that it loses the oxygen taken from the peroxide of hydrogen and re-forms the original metallic oxide.

In the presence of acids, the intermediate product undergoes a more decided decomposition with the evolution of oxygen and the formation of a salt. If the oxide employed contains "disposable" oxygen, that is to say oxygen in excess of that required to form a salt with the maximum amount (MnO_2, PbO_2, MnO_4H, CrO_3), this oxygen is given off at the same time as that from the peroxide of hydrogen, which causes the illusion of the simultaneous reduction of the metallic oxidiser and the peroxide of hydrogen. As a matter of fact, there is nothing but the more or less spontaneous decomposition of the superoxygenated product, formed by the fixation of the peroxide of hydrogen on the metallic oxide brought into the reaction.

To sum up, there is absolutely no reason to admit the existence of oxidisable hydrogen in the molecule of peroxide of hydrogen, as required by Traube's hypothesis. Another conclusion that may be drawn from the above-mentioned experiments is, that there is no fundamental difference between the catalytic decomposition of peroxide of hydrogen and its decomposition according to a definite equation.—*Moniteur Scientifique*, Series 4, vol. xvii., p. 26.

NOTICES OF BOOKS.

The Chemistry of the Terpenes. By F. HEUSLER, Ph.D. Authorised Translation by FRANCIS J. POND, M.A., Ph.D. London: J. and A. Churchill. 1902.

THE constant and rapid growth of our knowledge of the chemistry of the terpenes makes the task of writing a monograph on the subject one of peculiar difficulty, while at the same time the usefulness of such a monograph, in collecting and systematising our knowledge, is beyond dispute. Dr. Heusler's work is a most favourable specimen of a text book on one branch of organic chemistry. It was originally written for the *Handwörterbuch der Chemie*, and was subsequently published in book-form with corrections and additions. In it only well established and authenticated facts and theories are recognised, and the treatment is remarkable for its breadth of view and absence of partisanship Hence, an admirably well-balanced and comprehensive survey of the whole subject is presented. The discussion of the derivatives of Japan camphor has been much restricted owing to the enormous amount of work which has been done in this region, and the great amount of space which would be required for the adequate consideration of the subject. Copious references to original publications are given throughout the book. The translator has introduced into the text a large amount of new matter, embodying the results of investigations which have been made public since the appearance of the German edition. This book will undoubtedly be the standard book of reference on the subject of the terpenes for some time to come.

Organic Chemistry. By W. H. PERKIN and F. STANLEY KIPPING. New Edition. London and Edinburgh: W. and R. Chambers, Ltd. 1902.

THIS new edition of a handy book has been completely evised by the authors, and important additions have been

made to the first edition, some chapters having been entirely re-written. The characteristic features of this book—the emphasis of general principles rather than matters of detail, and the systematic and convenient arrangement of the text—have made it of unique value to the student of organic chemistry, for whom it provides an introduction of moderate difficulty to the subject. As instances of really excellent chapters may be mentioned those on the synthesis of ketones and fatty acids by the aid of ethyl aceto-acetate and ethyl malonate, and on optical and stereo-isomerism. The book fully deserved its favourable reception on its first appearance, and can be confidently recommended for general use.

Papers on Etherification and on the Constitution of Salts. By Alexander W. Williamson, LL.D., F.R.S., Alembic Club Reprints. No. 16. Edinburgh: The Alembic Club, and W. F. Clay. 1902.

The sixteenth volume of the Alembic Club Reprints contains Williamson's classical papers describing his researches on etherification and the constitution of salts. In the case of two papers read before meetings of the British Association, the short abstracts, which appeared in the reports of the meetings, are reprinted, as well as the papers themselves, in which the theory of etherification is elaborated, and the foundation laid for the theory of types.

The importance to the student of chemistry of being able to obtain access to the original papers of the pioneers of modern chemistry amply justifies the publication of these valuable reprints. Williamson's peculiarly clear and graphic treatment of his subject and directness of method make this particular volume both interesting and instructive reading.

The Testing of Chemical Reagents for Purity. By Dr. C. Krauch. Authorised Translation of the Third Edition By J. A. Williamson, F.C.S., and L. W. Dupre. London: Maclaren and Sons.

This is a translation from the latest German edition of Dr. Krauch's useful work, and contains some additions and corrections suggested by the author. The book includes, arranged in alphabetical order under the headings of the various reagents most commonly employed, details as to their examination for impurities and adulterations, short descriptions of their quantitative determination, their chief uses, and other chemical and physical data; thus incidentally comprising much miscellaneous general information, which will render it almost indispensable in the laboratory. One excellent feature, due to the translators, is the substitution for the numerous references to German text-books on chemical analysis the corresponding English works, which greatly increases its usefulness to English readers. The list of atomic weights at the end of the book requires revision, the values according to the latest determinations being in many cases different from those given, and solubility and other tables might well have been added. This work, which is essentially one of reference, should find a place in every laboratory, and will certainly be found concise and complete as well as handy for use.

Elementare Vorlesungen über Telegraphie und Telephonie. 2 Lieferung. ("Elementary Lectures on Telegraphy and Telephony." Part II.). By Dr. Richard Heilbrun. Berlin: Georg Siemens. 1902.

This small book contains three lectures on induction, electrostatics, and the chemical effects of currents. In the first lecture the somewhat difficult task of explaining the subject of magneto-electric induction and its applications has on the whole been satisfactorily performed. The second lecture, on electrostatics, presents no particular novelty of treatment, but follows the usual lines and describes familiar experiments and phenomena. The last lecture explains very briefly and simply the theory of electrolysis. This book, which is copiously and well illustrated, appears to be very suitable for the use of those who have no previous knowledge of the subjects dealt with.

Beiträge zur Chemischen Physiologie und Pathologie. ("Contributions to Chemical Physiology and Pathology"). Edited by Franz Hofmeister. Band III. 4-6 Heft. Braunschweig: Friedrich Viewig und Sohn. 1902.

The two most important papers in the November number of this journal are the first, on the existence in the liver of a ferment which is capable of decomposing glycogen, and another on casein. In the latter paper considerable information is given as to the acid properties, molecular weight, and conductivity of the casein from cow's milk, and also the preparation is described of a modification to which the authors give the name iso-casein, obtained from ordinary casein by drying at a temperature of 94—100° for from twelve to eighteen hours; the properties and behaviour of this modification are described in detail. The first paper discusses at some length the proofs of the existence and the quantitative determination of the activity of the diastatic ferment of the liver, and should do something towards elucidating the question as to the nature and action of this ferment.

OBITUARY.

HENRY EDWARD SCHUNCK, Ph.D., D.Sc., F.R.S., &c.

We regret to announce the death of Dr. Henry Edward Schunck, which occurred on Tuesday morning last, January 13th, at The Oaklands, Kersel, near Manchester, in the eighty-third year of his age. By his death Science loses a well known chemist, whose work on colouring matters has extended over many years.

Dr. Schunck was born in Manchester in 1820, and after completing his school education he was sent to Germany to study chemistry, with the ultimate intention of taking over the direction of his father's large print and calico works in Manchester. At Berlin, under Rose and Magnus, he made first-rate progress, and, finally, took the degree of Ph.D., under Liebig, at Giessen. On returning to England, Dr. Schunck engaged for some years in practical work, but finding this repugnant to his taste and inclination he gave it up, and devoted himself to pure science, his attention being directed more especially to the chemistry of colouring matters. Dr. Schunck's first research, "On the Action of Nitric Acid on Aloes," was carried out in Germany, and resulted in the discovery of a new and remarkable nitro-acid with curious optical properties; this he called "chrysammic acid." By the action of reducing agents on chrysammic acid a substance is produced resembling indigo blue; this is known as hydrochrysamide, and crystallises in blue needles with a coppery lustre. This body has formed the subject of many subsequent investigations.

The next subject investigated by Dr. Schunck was the class of substances contained in various species of lichens, and he read an important paper on this subject before the Chemical Society in 1842. Another paper on this subject appeared in 1846, "On the Substances contained in the Roccella Tinctoria," which derives its interest from the fact of its being that species of lichen from which the finest kind of archil dye is prepared.

From 1846 to 1855, Dr. Schunck was at work on the colouring matters of madder, then one of the most important dye-stuffs used in calico printing, but which has been replaced since by artificial alizarin. In 1854, amongst other papers, Dr. Schunck read one "On the Action of the Ferment of Madder on Sugar," and he dis-

covered the interesting fact, unique in the history of fermentation, viz., the production of succinic acid.

The important subject, the formation of indigo blue, next occupied Dr. Schunck's attention, and in 1855 he read a paper on this subject before the Literary and Philosophical Society of Manchester. On the discovery of the artificial formation of alizarin in 1867, Dr. Schunck undertook an investigation of the products formed at the same time, and discovered, partly in conjunction with Dr. Roemer, three new bodies isomeric with alizarin, viz., anthraflavic acid, iso-anthraflavic acid, and anthrarufin, which, strange to say, have no dyeing properties whatever; and in 1874 he read a paper on "Methyl-alizarin and Ethyl-alizarin."

One of Dr. Schunck's most interesting researches was commenced in 1879, and the first communication on the subject was read to the Chemical Society in September of that year, entitled "On the Purple of the Ancients." This colour, which in ancient times was extracted from various kinds of sea shell-fish, and applied to the dyeing of linen and woollen fabrics, has been made the subject of numerous treatises.

Besides being a Fellow of the Chemical Society, Dr. Schunck was elected a Fellow of the Royal Society in 1850; he has also held the positions of Secretary, Vice-President, and President of the Manchester Literary and Philosophical Society, and was President of the Chemical Section of the British Association at its meeting in Manchester in 1887.

Dr. Schunck's funeral is arranged to take place on Saturday, the 17th inst. at St. Paul's Church, Kersal, at 1 o'clock.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
Series 3, Vol. xxvii., No. 10.

A New manner of Manipulating Liquid Gases in Sealed Tubes.—H. Moissan.—Already noticed.

Decomposition of Calcium-ammonium and Lithium-ammonium by Chloride of Ammonium.—H. Moissan.—Already noticed.

Electrolysis of Chloride of Ammonium in Solution in Liquefied Ammonia.—H. Moissan.—Already noticed.

Action of the Ammonium Metals on Sulphuretted Hydrogen.—H. Moissan.—Already noticed.

New Treatment of Niobite; Preparation and Properties of Cast Niobium.—H. Moissan.—Already noticed.

Preparation of Tantalum in the Electric Furnace, and on its Properties.—H. Moissan.—Already inserted in full.

Attempt to Decompose Monochlorosulphonacetic Acid (Monochlorosulphonethanoic Acid).—Ch. Porcher.—Cinchonine and strychnine are very convenient for the decomposition of racemic chloro-sulphonacetic acid. Thus, with only 45·75 grms. of acid, requiring 154·20 grms. of cinchonine, the solution made up to 4225 c.c. brings about a very distinct separation; 100 grms. of a first salt are precipitated in very fine crystals, the other 100 grms. remain dissolved, and they are extracted partially from the aqueous solution by means of several concentrations. The two salts of cinchonine thus obtained are purified by one or two crystallisations; both are strongly dextrogyre. When re-dissolved separately in water and treated with a slight excess of ammonia, the cinchonine is precipitated; it is filtered, and the filtrate concentrated on the water-bath at a temperature not higher than 50°; this also drives off the excess of ammonia. From the first salt of cinchonine a levogyre ammoniacal salt is obtained, from the second a dextrogyre salt.

Some Phenolic Urethanes of Piperidine.—M. Bouchetal de la Roche.—If to 2 molecules of piperidine we add 1 molecule of carbonate of ortho-chlorophenyl the mixture becomes heated; the reaction is completed on a boiling water-bath; on cooling, the urethane crystallises out. It is washed with soda, and re-crystallised twice in alcohol at 93°. In this manner colourless octahedral crystals are obtained, fusible at 119°, boiling at 148—149° under 273 m.m. From 1 molecule of carbonate of para-chlorophenyl and 2 molecules of piperidine, a yellow oily mass is obtained, which does not crystallise on cooling, but becomes solid on contact with a solution of soda; a body is formed, fusible at 65°, boiling at 218—219° under 23 m.m. Eight grms. of piperidine, mixed with 27·7 grms. of carbonate of penta-chlorophenyl, gives a body which solidifies on cooling. On crystallising in benzene, small white crystals are obtained, fusible at 123°, boiling at 259° under 11 m.m. It is slightly soluble in alcohol. The author also describes the preparation and properties of the ortho-, meta-, and para-cresylic urethanes of piperidine, the eugenolic urethane of piperidine, and urethane of thymol.

The Hydrogenases of the Blood, and the Catalytic Properties of Fibrin.—E. Pozzi-Escot.—Freshly prepared fibrin decomposes peroxide of hydrogen, but it loses this property after a time, or even immediately if heated to above 70°; certain salts, such as those of the heavy metals, and the nitrates and nitrites in strong doses, act energetically as paralysing agents. This singular property of fibrin has been characterised, up till now, by the vague expression "catalytic action"; catalytic actions have had their day as mysterious phenomena, and in most cases these actions can be shown to be definite chemical actions; however, no satisfactory explanation has been given as far as fibrin is concerned. If, however, we consider the origin of this substance and the powers possessed by the diastases to fix themselves with great energy to certain inert bodies, we see that it is only natural to expect that fibrin owes its catalysing power to the presence of an ion of hydrogen connected with a hydrogenase. The author has proved that the hydrogenases do exist in the blood, where their property of reducing agent is certainly very important.

An Important cause of Error in the Detection of Diastases.—E. Pozzi-Escot.—Already noticed.

Passive Iron.—A. Finkelstein.—The author has measured, by Nernst's method, the polarisation capacity and the resistance of passive iron; he has determined the potential of passive iron in contact with different electrolytes, as well as the curves of decomposition of solutions of iron in contact with iron electrodes. In this manner he has observed that passive iron is covered with a badly conducting layer, and that it behaves like an electrode of oxygen of variable concentration. The electromotive force of an electrode of iron with regard to a solution containing a constant quantity of iron is a function of the proportion of ferric ions to the ferrous ions. The electromotive force is lowered by additions of cyanide of potassium. The curve of cathodic decomposition of the ferric salts shows that the iron is deposited with the properties of a noble metal. The curve of the anodic polarisation of iron enables us to observe very distinctly the commencement of passivity. The corresponding potential does not depend on the acidity, and it diminishes with the richness of the iron in solution. The hypothesis, according to which the passivity may be explained by a layer of oxide, ought to be abandoned; it may be, on the other hand, that passive iron consists of trivalent iron in the metallic state.—*Zeit. Physik. Ch.*, vol. xxxix., p. 91.

MEETINGS FOR THE WEEK.

TUESDAY, 20th.—Royal Institution, 5. "The Physiology of Digestion," by Prof. Allan Macfadyen, M.D.

—— Society of Arts, 8. "Principles which should Guide all Applied Art," by G. F. Bodley, R.A.

WEDNESDAY, 21st.—Chemical 5.30. "Researches on Silicon Compounds—Part VIII., Interactions of Silicophenylamide with Thiocarbamide," by J. Emerson Reynolds. "Phenocycloheptane," by F. S. Kipping and A. E. Hunter. "On the Relation between the Absorption Spectra and the Chemical Structure of Corydaline, Berberine, and other Alkaloids" and "The Absorption Spectra of Laudanine and Laudanoxine in Relation to their Chemical Constitution," by J. J. Dobbie and A. Lander. "The Influence of Molybdenum and Tungsten Trioxides on the Specific Rotations of *l*-Lactic Acid and Potassium *l*-Lactate," by G. G. Henderson and J. Prentice. "Estimation of Ethyl Alcohol in Essences and Medicinal Preparations," by T. E. Thorpe and J. Holmes. "Carbon Monoxide as a Product of Combustion of the Bunsen Burner," by T. E. Thorpe. "Derivatives of β-Resorcylic Acid and of Protocatechuic Acid," by W. H. Perkin, jun., and E. Schiess. "Synthesis of Imino-ethers—N-Ethyl-, Methyl-, and Benzyl-benzimino-ethers," by G. D. Lander. "A Synthesis of 1.3.5-Triphenyl-2.4-dimethyl-cyclopentane and of 1.3.5-Triphenyl-1.2-methyl-cyclopentane" and "The Condensation of Phenylethylketone (Propiophenone) with Benzalacetophenone, and of Acetophenone with Benzalpropiophenone," by R. D. Abell. "Formation of Carbazoles by the Interaction of Phenols, in the Orthoketonic Form, with Arylhydrazines," by F. R. Japp and W. Maitland. "Bimorphism of α-Methylanhydracetonebenzil" and "The Oxidation Products of the Methyl Homologues of Anhydracetonebenzil," by F. R. Japp and A. C. Michie.

—— Microscopical, 8. Annual Address by the President.

—— Society of Arts, 8. "The Metric System," by A. Sonnenschein.

THURSDAY, 22nd.—Royal Institution, 5. "Pre-Phœnician Writing in Crete, and its Bearings on the History of the Alphabet," by A. J. Evans, F.R.S.

—— Society of Arts, 4.30. "Indian Domestic Life," by John David Rees, C.I.E.

FRIDAY, 23rd.—Royal Institution, 9. "Recent Volcanic Eruptions," by Tempest Anderson, M.D., B.Sc., F.G.S.

SATURDAY, 24th.—Royal Institution, 3. "The Bi-centenary of Samuel Pepys—His Musical Contemporaries, Criticisms and Compositions" (with Musical Illustrations), by Sir Frederick Bridge, M.V.O., Mus.Doc.

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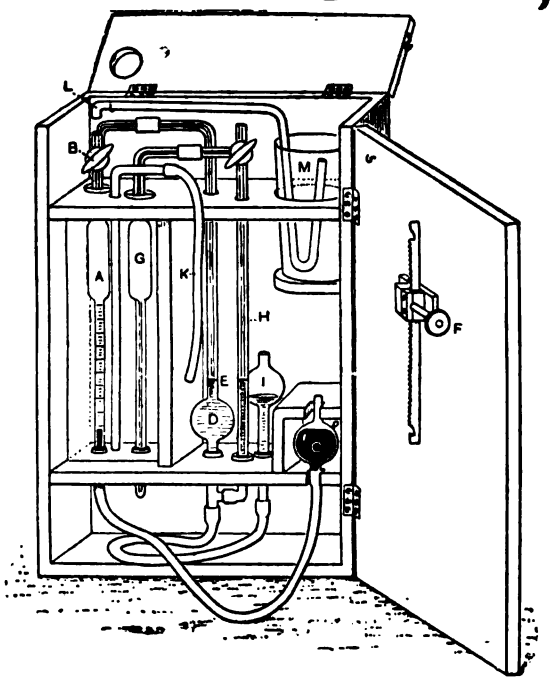

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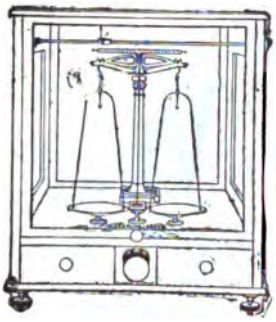

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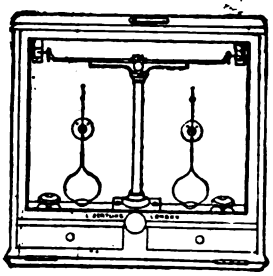

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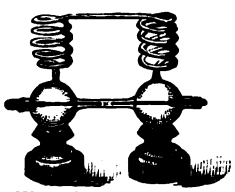

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THE CHEMICAL NEWS.

Vol. LXXXVII., No. 2252.

MODIFICATIONS OF HEMPEL'S GAS-APPARATUS.*

By THEODORE WILLIAM RICHARDS.

The object of this paper is the description of some simple devices which make possible the accurate analysis of gases with a minimum of special apparatus.

I. *Absorbing Pipette.*

The essential feature of Hempel's method is the use of simply constructed vessels distinct from the measuring

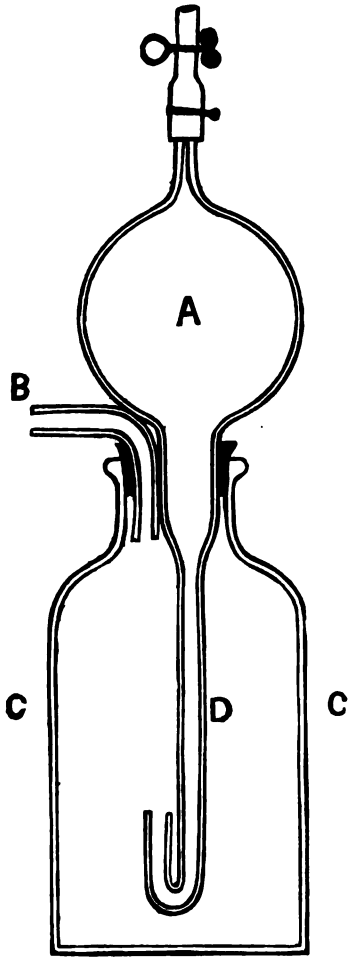

Fig. 1.

burette for the purpose of absorbing successively the various constituents of a gaseous mixture. Hempel used for this end a modification of Ettling's gas pipette, which answers the purpose admirably; but of course many other combinations of apparatus might be used. The simplest is perhaps a bulb or wide tube inserted over liquid contained in a bottle. In order to prevent the access of air into this bulb from below, it is well to make the lower part of the tube somewhat narrow, and to bend it upward. If desired, the capillary serving to admit the gas may be bent downwards and then upwards, as it is in the Hempel pipette; but with intelligent use of the pinch-cock this precaution is not necessary. A satisfactory form of the apparatus is illustrated in Fig. 1.

Fifty c.c. is quite enough gas for analysis, if a suitably narrow burette is used for measurement; hence the receiving bulb of the pipette (A) need not exceed 75 c.c. in capacity. The bottle (C) should be capable of holding 150 c.c. in this case.

The "compound pipette" of Hempel may be imitated by the addition at B of another bottle containing water and a levelling funnel, or the same object may be attained merely by connecting to the outlet B a flexible rubber bulb, such as a child's toy balloon.

For solids, the stem D of the pipette may be made of wider tubing, closed at the bottom with a perforated

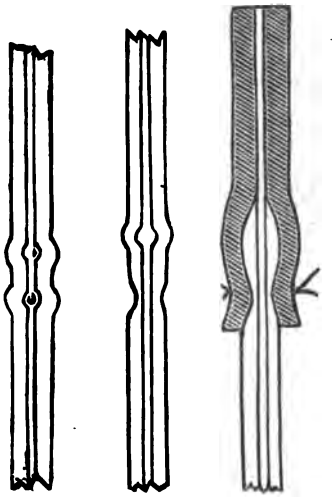

Fig. 2.

stopper. A small tube bent upwards may be inserted in this perforation, if especial precaution against incoming air is desired.

An explosion-pipette could be made of similar apparatus, with the addition of a stopcock just below the bulb A and the usual conducting wires.

The pipette for fuming acid might be made with a ground-glass joint instead of a stopper to connect bulb with bottle. In that case the bottle should be provided with a suitable side tube on the neck, bent upwards.

The method of using these pipettes will be understood without difficulty by any one familiar with the Hempel apparatus.

II. *Measuring Apparatus.*

The most serious cause of error in Hempel's ordinary apparatus is due to the possible change of temperature. This is considerably greater than the probable error in reading; for a single degree Celsius causes an error of 0·5 per cent of the total volume of gas measured under ordinary conditions, while the volume is easily read within 0·05 per cent. Hence, unless much greater care than usual is taken to preserve constant temperature, the reading of the volume is unnecessarily precise. But Hempel's ingenious arrangements for maintaining constant conditions in a 100 c.c. burette are so large as to be inconvenient for students' use in cramped quarters

* Contributions from the Chemical Laboratory of Harvard College. From the *Proceedings of the American Academy of Arts and Sciences*, vol. xxxvii., No. 10.

For these reasons I have often used somewhat smaller volumes, which may be surrounded with an envelope of water without producing thereby an unwieldly combination. An ordinary 50 c.c. burette, inverted and provided with a levelling bulb or funnel, answers very well as a measuring instrument. The burette may even be used in its usual position, if it is provided above with a smooth rubber stopper with a single hole for the capillary connecting tube. Of course the stopper is always pushed precisely into a definite position, indicated by a carefully made mark on the burette. There is little risk of displacing this stopper if it is firmly wired into place. In any case of course the ungraduated space at the upper extremity must be carefully calibrated. An especially made 50 c.c. instrument, graduated all the way to the capillary tube at the top, is more convenient, although no more accurate than the inverted burette. For convenience in cleaning, it is well not to have both ends of the burette drawn down to small diameter. The small size of the burette makes it easily possible to provide the water jacket which is so essential for accurate work, and both burette and pipette may be supported upon the ordinary iron ring-stand.

III. *Practical Operation.*

Of course the precautions usually necessary in gas analysis must be used in all the operations with this apparatus. For example, due time must be allowed for the running down of the liquid from the moistened walls. Again, care must be taken that the same amount of gas, at definite pressure (as small an amount as possible) is always left in the connecting capillary tubes. In order to make sure that no air-bubbles are caught, it is well to draw out the ends of the tubes in the manner illustrated in the diagram, which indicates two successive stages of the glass blowing, as well as the finished and connected nipple. The object of blowing the small bulbs is to render the bore of the portions drawn out as large as that of the rest of the tube.

While the apparatus thus constituted was devised primarily for use in an emergency, it has several advantages over the Hempel apparatus. It dispenses with the necessity of calibrating the whole length of a new burette, it is very inexpensive, and it occupies but little space. Each student may possess a complete set of apparatus, and every one knows the value from a pedagogic standpoint of such a possibility. A further advantage lies in the fact that the pipette is easy to fill and to clean; and a precipitate in the liquid is not apt to clog its working. The short straight capillary brings an obvious gain of speed in transferring. Moreover, because of this speed, and the fact that the pressure during transferrence is always from the outside inward, the danger of loss by leakage is considerably less than it is with Hempel's apparatus. It is well known that in a rubber tube an internal pressure may cause leakage, while an external pressure tends to stop small outlets by causing the rubber tube to be pressed more closely together.

On the other hand, the calculation is less obvious, because the volume taken is not just a 100 c.c.; and somewhat more care must be used to prevent the access of air into the pipette from below while shaking. A little practice enables one to shake thoroughly the liquid in the bulb without much agitation in the bottle if the movement is hinged about the point D; hence the danger is slight. Another slight difficulty is the possible leakage of the absorbent around the stopper of the pipette bottle—an unpleasant occurrence which has no effect upon the accuracy of the method.

In presenting for general use any new instrument one must record its practical working in the laboratory. Everybody knows that plausible inventions do not always stand the test of indiscriminate use. Accordingly a large class in gas analysis has been asked to use the new devices, with favourable outcome.

Analysis of known Mixtures of Air and Carbon Dioxide.

Volume CO_2 taken.	Volume air taken.	Volume air found.	Error.
c.c.	c.c.	c.c.	c.c.
16·95	32·02	32·01	−0·01
18·45	32·21	32·12	−0·09
12·20	42·20	42·20	±0·00
20·00	32·00	32·10	+0·10
14·90	37·60	37·60	±0.00
13·00	34·50	34·48	−0·02
16·50	36·50	36·55	+0·05

Excess of positive over negative errors, 0·03.

The pipette and burette were tested as follows:—A definite amount of air was run into the burette, and the volume measured with the usual care. Pure carbon dioxide was then run in from a generator, and the gain in volume was noted. This known mixture of air and carbon dioxide was run over into the new pipette, and after suitable shaking the residual air was returned to the burette and measured.

These figures, taken at random from among the results of the class, agree with one another as well as could be expected; and since the positive deviation balances the negative, there is no constant error. No trouble was experienced as to manipulation.

I am much indebted to Mr. Bisbee, the assistant, and to the gentlemen of the class in gas analysis, for their kindness in carrying out the practical trial of the apparatus.

THE GASES FROM SOME MINERAL WATERS.

By C. MOUREU.

I. Until quite recently, when making an examination of the gases given off by mineral springs, we have only accounted for oxygen, nitrogen, carbonic acid, sulphuretted hydrogen, hydrogen, and a few hydrocarbons.

Since the brilliant discovery of argon by Lord Rayleigh and Prof. Sir Wm. Ramsay in 1894, the attention of physicists and chemists has been drawn to the various gaseous sources met with in nature.

We may recall here the researches of M. Bouchard on the waters from Cauterets in 1895, our own practical experiments in the same year on the gas from Maizières (Côte-d'Or), and those of MM. Bouchard and Desgrez on the spring at Bagnoles-de-l'Orne in 1896.

The subject of this paper is the examination of five new sources of mineral gases. They are all situated in the Pyrenean regions. Four are in French territory; they are the springs at Peyré d'Ogeu (Lower Pyrenees), Nehe or Fontaine-Chaude, at Dax (Landes); Trou des Pauvres, at Dax (Landes); and Vieille, at Eaux-Bonnes (Lower Pyrenees); the fifth is the Saint-Augustin Spring, at the celebrated Panticosa station, situated at an altitude of 1650 metres, in Aragon, in Spanish territory.

In all these sources the gaseous mixtures are very rich in nitrogen, and make their escape spontaneously in more or less voluminous bubbles at the source of the spring.

The samples were collected and transported with all the necessary precautions to prevent their mixture with air, and we examined the various gases in the following manner in the laboratories of M. Moissan.*

II. A preliminary analysis is made first over mercury; the carbonic acid is absorbed by means of potash, and the oxygen with pyrogallate of potash. These two gases are always present in small proportions, and the residue has all the general characteristics of nitrogen.

* The gases from the two springs at Dax were collected and transported with the greatest care by M. Vielle, a well-known pharmacist in this town. We are equally indebted to MM. Caraux, Espina y Capo, and E. G. Y. Echauri for their assistance at the springs at Eaux-Bonnes and Panticosa.

The argon and its allied gases can only be found in the residual nitrogen. The nitrogen is combined with calcium, and the new residue is submitted to spectrum analysis. In actual practice the raw natural gas was first left in prolonged contact with potassic hydrate and fused potash successively, being thus freed from carbonic acid and perfectly dried; it was then heated at a dull red heat, according to M. Maquenne's method, in the presence of an intimate mixture of 5 parts of anhydrous lime and 3 parts of perfectly dry magnesium, a mixture which fixes both the oxygen and the nitrogen at the same time. The spectroscopic examination was then made in Plucker tubes with aluminium electrodes, under a pressure of 2 to 3 m.m. of mercury.

III. The five samples of natural gas examined have all given non-absorbable residues, and each residue showed the characteristic argon lines in the spectroscope.

M. Deslandres was kind enough to complete this spectrum analysis, and he showed that in the gas from the Vielle d'Eau-Bonnes there was a certain proportion of helium, that rare gas which has been known for a long time to exist in the solar photosphere, and which was isolated by Sir Wm. Ramsay in 1895 from clèveite and some other minerals. From this same spring we may add that we have observed various lines in the spectrum which do not appear to belong to argon or to helium; these will be identified later on.

The following are the compositions, by volume, expressed in hundredths, of the different natural gaseous mixtures that we have examined. Each analysis is preceded by a few summary remarks on the corresponding water from the same spring:—

Spring at Peyré.—A lithia water containing 0·225 grm. of mineral matter per litre; temperature, 19·5°:—

Nitrogen	90·6
Oxygen	5·7
Carbonic acid	2·8
Argon	0·9

Spring at Nehe, or Fontaine-Chaude.—A water containing calcic sulphate and a little sodic chloride; 1·024 grms. of mineral matter per litre; temperature, 64°:—

Nitrogen	96·6
Oxygen	1·0
Carbonic acid	0·8
Argon	1·6

Spring at Trou des Pauvres.—A sulphurous water containing 0·576 grm. of mineral matter; temperature, 32°:—

Nitrogen	98·2
Argon and helium	1·8

(The analysis of this gas was made by M. Garrigou before the discovery of argon or helium, and he concluded naturally that it was pure nitrogen).

Spring at Saint-Augustin, Panticosa.—A siliceous water, rich in organic matter, containing 0·126 grm. of mineral matter per litre; temperature, 30°:—

Nitrogen	97·0
Oxygen	1·6
Carbonic acid	0 2
Argon	1·2

(This gas had already been analysed by MM. Saenz-Diez and Bonet; apart from the argon, which was not known at the time of their analysis, the results obtained by these two gentlemen are very close to our own).

We can see from the above that the gases from the five sources examined are very rich in nitrogen; all contain argon, while that from Eaux-Bonnes also contains helium.

It is interesting to compare these analyses with those already published of different natural gases. Such a comparison immediately draws attention to the spring at Maizières (Côte-d'Or) examined by us in 1896; the gas, which escapes from this spring in large bubbles, contains an enormous proportion of argon and helium (about 80 per cent), and is actually the richest source of helium known.

We may add that the interest attached to this class of research is far from being exhausted. Krypton, neon, and xenon, three other gases that Sir Wm. Ramsay has recently discovered in atmospheric air, may be expected to be met with; and for this reason there is a strong inducement to examine the various sources of natural gases very minutely.

The question also merits attention from another point of view. We know how complex is the problem of the action of mineral waters on the human economy; we are of the opinion that no point should be overlooked, and that in the present state of our scientific knowledge it would be at the least risky to refuse to any element a place in therapeutic action.—*Journ. de Pharm. et de Chim.*, Series 7, vol. xvii., No. 2.

THE INFLUENCE OF CARBONIC ACID ON DIASTASIC ACTION.

By O. MOHR.

The papers published by Baswitz in the *Berichte der Deutsch. Chem. Gesellsch*, in 1878 and 1879, are rarely referred to in spite of their importance. Baswitz has shown, as a matter of fact, that carbonic acid helps the action of amylase as a general rule; with certain starches we obtain no appreciable saccharification with small doses of diastase when carbonic acid is rigorously excluded; on the other hand, with other starches the saccharification reaches almost the same point, either with or without carbonic acid gas. Baswitz is of the opinion that in the latter case the starch contains substances capable of helping the amylase to the same extent as carbonic acid does.

I have endeavoured to decide whether the reaction of the starch is of any importance, by watching at the same time the effect of small additions of acids or of alkalis.

An emulsion was prepared of 2·5 grms. of air-dried starch and 200 c.c. of water, and the temperature kept at from 53°—55°. Five c.c. of cold extract of malt (5 grms. per litre of water) was added, and one portion left protected from carbonic acid, while the other portion was placed in an atmosphere of this gas, and both of them kept at 53—55° for two hours.

Both vessels were then plunged into boiling water, cooled, and made up to 250 c.c. The estimation of the maltose was made on 25 c.c., corresponding to 0·25 grm. of starch. All quantities of maltose less than 5 milligrms. in copper reduced, were termed traces.

The following experiment was made on six samples of starch; two had a neutral reaction, one slightly alkaline, one strongly alkaline, one acid, and one was soluble starch with a slightly alkaline reaction.

Starch. Reaction.	Maltose, per cent of dry matter of the starch. Without CO_2.	With CO_2.
I. Neutral	Traces	32·4
II. Slightly alkaline	,,	31·8
III. Strongly alkaline	,,	39·89
IV. Acid	About 10 per cent	25·56
V. Souble starch. Slightly alkaline	,, 5 per cent	31·35
VI. Neutral	,, 8 per cent	29·51

The maximum amount of maltose was realised by a starch with a strongly alkaline reaction in the presence of carbonic acid.

From this we cannot conclude that the action of the carbonic acid has reached its maximum in giving 30 32 per cent of maltose, since sample III. has given nearly 40 per cent, and a portion of the carbonic acid gas has passed to the state of bicarbonate, thanks to the alkaline reaction of the starch.

The following series of experiments made with the neutral starch, No. VI., shows that the action of the carbonic acid is made still more favourable by the presence of asparagine. This sample being able by itself to effect the saccharification with very little asparagine, 0·01 for 250 c.c. of 1 per cent emulsion, the maximum is attained by the simultaneous action of the carbonic acid gas and some acid; with 0·05 of asparagine, the amount of maltose is almost independent of the carbonic acid, and finally with quantities of amides of 0·1 to 0·5 grm., the saccharification is slightly retarded by the carbonic acid; it is also less advanced than with smaller doses of asparagine. There is, therefore, an *optimal* dose for this substance.

The results obtained were as follows:—

Asparagine per 2·5 of starch.	Maltose per cent of dry starch. Without CO_2.	With CO_2.
0·00	About 8·00	29·51
0·01	30·30	36·26
0·05	36·17	35·16
0·10	44·07	33·20
0·20	43·16	33·25
0·50	38·32	33·29

The following table gives the results obtained with increasing doses of lactic acid, with or without the simultaneous presence of carbonic acid:—

Lactic acid, per 2·5 of starch. M.grms.	Maltose, per cent of dry starch. Without CO_2.	With CO_2.
1	34·78	17·87
2	23·57	12·69
20	Traces	Traces

The favourable action of lactic acid by itself is interfered with or reversed by carbonic acid, and this is confirmed by the fact that quantities of lactic acid of 2 m.grms. per 250 c.c. of solution, interfere with the production of maltose, and that 10 m.grms. stop the saccharification.

On the other hand, the liquefying action is in no way interfered with, which shows once again that liquefaction and saccharification are entirely independent.

Finally, we took the starches III., IV., and VI., and with them made 1 per cent emulsions, adding, at the same time, 1 m.grm. of lactic acid per 2·5 of starch; the experiments were then completed, with and without carbonic acid.

No.	Reaction.	Maltose, per cent of dry matter. Without CO_2.	With CO_2.
III.	Alkaline	About 8 per cent	41·10
IV.	Acid	33·72	31·65
VI.	Neutral	34·78	17·87

We are enabled to draw the following conclusions from these experiments:—

1. The variations in the amounts of maltose formed by small quantities of diastase in the absence of carbonic acid do not appear to be due entirely to the reaction of the starch; still an acid action of the starch appears to be more favourable.

2. In the presence of carbonic acid, with the different starches experimented with, we obtain almost the same proportion of maltose, *i.e.*, 30 to 32·5 maltose, per cent of the dried starch.

3. The favourable action of asparagine is increased by carbonic acid if the acid is in very small quantity, and, on the other hand, it is interfered with if the dose is too great.

4. The favourable action of lactic acid is stopped by carbonic acid as soon as the optimal amount of lactic acid is exceeded. This optimal amount varies with the nature of the starch employed.

5. Carbonic acid has a favourable action only when using small quantities of amylase.—*Woch. fur Brauerei*, 1902, p. 94.

ON THE DETERMINATION OF LEAD IN ORES.*

By IRVING C. BULL.

The ordinary fire assay for lead in ores is frequently so erroneous in its results as to cause great dissatisfaction. With most ores the results are considerably too low (about 2 per cent) and with others notably too high, *i.e.*, in oxidised ores containing iron, copper, antimony, and bismuth the lead button may contain several per cent of such impurities, and so weigh more than warranted by analysis.

The object of this article, therefore, is to test and compare the best existing methods in order to select a method which may be recommended both because of its accuracy and rapidity. A number of schemes, gravimetric, volumetric, and electrolytic, have been proposed, but most of them have proven either too lengthy and troublesome or too inaccurate.

The first method which is to be examined, and which is to be taken as the basis of comparison with other methods, is the method of weighing the lead as lead sulphate. This method is to be tried upon six samples of lead ore obtained from different sections of this country and carrying various amounts of lead and impurities.

Each of these ores was first ground in an iron mortar, and then finished upon a bucking board until fine enough to pass through a hundred-mesh sieve; the last traces of ore not fine enough were ground in an agate mortar and passed through the sieve, then the whole was thoroughly mixed and quartered down to a small sample tube full of each ore, leaving about one quart of each ore in reserve. Again, the samples thus obtained were ground in an agate mortar to an impalpable powder, in order to get as complete solution of the ore as possible. It might be well to emphasise frequently that more errors are made by incomplete solution of the ore than is ordinarily supposed.

Weighed amounts of each of the ores were carefully spread over a watch-glass so as to expose as much surface as possible, and moisture in each determined by drying in an air-bath at 110° C. to constant weight. This work was performed so as to make, if necessary, any corrections in the lead percentages afterwards obtained. The moisture was as follows:—

1.	.. ..	0·00 per cent
2.	.. ..	0·36 ,,
3.	.. ..	0·25 ,,
4.	.. ..	0·42 ,,
5.	.. ..	0·32 ,,
6.	.. ..	0·14 ,,

The sulphuric acid and other chemicals used were tested for lead, but none was found. Distilled water was used throughout.

The six ores were first assayed before commencing the work of comparison, so as to make this comparison as complete as possible. The assays were conducted as described in the "Notes on Assaying," by Ricketts and Miller, depending upon the character of the ore; *i.e.*, whether a sulphide, sulphate, or carbonate. Care was exercised in every case to obtain the best agreeing results. They were as follows:—

1.	Galena	76	per cent
2.	,, ...	37	,,
3.	Cerussite	9	,,
4.	Sulphuret, galena, and sphalerite ..	24·7	,,
5.	Galena and stibnite	28·7	,,
6.	Cerussite	37·8	,,

* Contribution from the Havemeyer Laboratories, Columbia University. From the *School of Mines Quarterly*, xxiii., No. 4.

Part I.

A. *Gravimetric—Lead Sulphate.*

The following gravimetric methods were then carried out on each of the six ores, first weighing the lead as lead sulphate.

Method.—Dissolve three-tenths to one grm. of the finely-ground ore (depending upon the amount of lead in the ore) in 15 c.c. of concentrated nitric acid and a few drops of hydrochloric acid in a covered casserole or beaker, boiling until the ore is completely decomposed and the sulphur oxidised, adding more of each of the acids if decomposition seems to be incomplete. Cool slightly and add 10 c.c. of diluted sulphuric acid (sp. gr. 1·41) and evaporate to fumes of sulphuric anhydride. Near the end it is well to hold the casserole or beaker in the hand over the flame in order to prevent bumping and spattering; thick dense fumes of sulphuric anhydride are absolutely necessary to ensure complete conversion of the lead to sulphate.

Cool and add carefully 100 c.c. of distilled water, and boil for five minutes to dissolve any ferric salts that may have formed by evaporation. Cool and add 15 c.c. of 95 per cent ethyl alcohol, stir well, settle and decant through a small filter, leaving as much as possible of the residue of lead sulphate, calcium sulphate, barium sulphate, strontium sulphate, &c., in the casserole. Wash the residue thoroughly with a solution containing 1 per cent of sulphuric acid and 10 per cent. of alcohol, using about 400 c.c. in all; finally with alcohol alone, pouring the washings through the filter each time.

Dissolve the lead sulphate from the residue in the casserole in a strong hot solution of ammonium acetate, slightly acid with acetic acid; pour the solution through the filter into a clean beaker. The filter is best moistened with ammonia in order to form ammonium acetate with the free acetic acid in the ammonium acetate solution, in contact with the few particles of lead sulphate on the paper, and so bringing them in solution much easier. Repeat this until all the lead sulphate is dissolved, then wash the contents of the casserole on to the filter, first with dilute ammoninm acetate and then with hot water. The reaction which has resulted is as follows (Treadwell, *Qualitative Analysis*, p. 144) :—

$$2PbSO_4 + 2NH_4C_2H_3O_2 = Pb\begin{matrix}C_2H_3O_2\\C_2H_3O_2\end{matrix} + \begin{matrix}SO_2{-}O{-}NH_4\\O\\O\\SO_2{-}O{-}NH_4\end{matrix}>Pb .$$

Acidify the filtrate with sulphuric acid, adding alcohol as before, and filter upon a Gooch crucible. The Gooch crucible is fitted carefully with two layers of quantitative filter-paper in the bottom, then a very thin layer of asbestos, previously washed with dilute sulphuric acid, was laid on top of the filter-paper, making about three-sixteenths of an inch over all. This was sucked down by a strong suction as tight as possible, then dried in an oven at 110° C. to constant weight. The solution containing the lead sulphate was then filtered through, starting the suction very slowly and wetting the asbestos before starting, then washing the precipitate as previously described, and finally with absolute ethyl acohol, using considerable quantity. The crucible (and precipitate) is again dried at 110° C. in an air-bath, and weighed.

$$\frac{\text{Weight of lead sulphate} \times 0{\cdot}6829}{\text{Weight of ore taken.}} = \text{per cent lead.}$$

The method of filtering on a filter-paper, burning off the paper and igniting as described, generally was found to be very inaccurate as well as troublesome in manipulation; it was, therefore, filtered on a Gooch crucible, which simplified matters considerably.

The results obtained by this method upon the ores taken were as follows, which agreed more closely than those obtained using the old way of weighing the lead sulphate:—

1.	.. .. ..	78·68 per cent 78·62 ,, 78·65 ,,
2.	.. .. ..	37·20 ,, 37·26 ,, 37·22 ,,
3.	.. .. ..	10·76 ,, 10·74 ,,
4.	.. .. ..	18·43 ,, 18·40 ,,
5.	.. .. ..	27·25 ,, 27·21 ,,
6.	.. .. ..	38·50 ,, 38·54 ,, 38·51 ,,

B. *Gravimetric—Lead Chromate.*

Proceed in this method exactly as described in the preceding method until the lead sulphate is dissolved in ammonium acetate. This solution is then brought to boiling and a fifth normal solution of potassium dichromate run in until all the lead is precipitated, and the solution above the precipitate, when the latter settles, possesses the dichromate colour. Then the solution is boiled vigorously for three minutes and filtered upon a weighed Gooch crucible prepared as described in the preceding method. The precipitate of lead chromate should be washed thoroughly with hot water until the washings possess no colour of dichromate. The same precautions should be observed here as in weighing the lead sulphate as described. The crucible and precipitate are then dried at 110° C. to constant weight. Too high heat must not be permitted in drying, as the filter in the bottom of the crucible will become charred and so give poor results. It is possible with the lead chromate to omit the layer of the filter-paper. The following are the results obtained by using the above method as described:—

1.	.. .. ..	78·68 per cent 78·71 ,,
2.	.. .. ..	37·28 ,, 37·30 ,,
3.	.. .. ..	10·77 ,, 10·74 ,,
4.	.. .. ..	18·45 ,, 18·40 ,,
5.	.. .. ..	27·23 ,, 27·20 ,,
6.	.. .. ..	38·47 ,, 38·50 ,, 38·48 ,,

C. *Electrolytic—Lead Peroxide.*

Obtain the acetate solution of the lead in the ore in exactly the same way as described in the gravimetric lead sulphate method.

Dilute if necessary to a bulk of 200 c.c., add 20 c.c. of nitric acid (sp. gr. 1·35), warm to 60° to 65° C., and electrolyse with a current of $N.D._{100} = 1{\cdot}5$—1·7 ampères; the electrode tension is without influence upon the condition of the peroxide, and may vary within wide limits. If the warming is continued during the operation, the precipitation of quantities up to 1 and 1½ grms. of lead peroxide is completed in about three hours, with larger quantities in about four to five hours. Complete precipitation is ensured by adding about 20 c.c. of water, and observing whether the freshly wetted surface of the electrode becomes darker. In case no blackening is observed at the end of ten to fifteen minutes, the current is stopped after removing the electrodes from the solution, and the precipitate is washed with water, finally with alcohol, and dried at 180° C., and weighed. The residue is anhydrous peroxide. The preceding method permits of the separation of lead from zinc, iron, nickel, cobalt, copper, gold, cadmium, mercury, antimony, and aluminium; in the presence of silver and bismuth, traces of

those metals in the form of peroxide pass over into the lead peroxide.

If the anode is roughened a greater amount of lead peroxide can be collected. Chlorine compounds must not be present in the solution for electrolysis. Manganese under the most favourable conditions is precipitated along with the lead, it being the only commonly occurring element that behaves similarly.

The following are the results obtained by proceeding with the method as above stated:—

1.	78·73	per cent
2.	37·35	,,
3.	10·80	,,
4.	18·58	,,
5.	27·32	,,
6.	38·60	,,

Part II.—Volumetric Methods.

D. *H. H. Alexander's Ammonium Molybdate Method.*

The decomposition of the ore and the method in general is followed exactly as in the gravimetric lead sulphate method as previously described, up to the point of dissolving the lead sulphate in ammonium acetate, instead of dissolving the lead sulphate from the other foreign sulphates upon the filter-paper; the filter-paper and the precipitate are put into the ammonium acetate solution, and digested for at least ten minutes in order to completely dissolve the lead sulphate; the solution should be acidified with acetic acid, diluted to 200 c.c. with hot water, boiled, and a standardised solution of ammonium molybdate run in from a graduated burette, until all the lead is precipitated, stirring the solution very thoroughly when near the end, and waiting a few moments before adding a drop of the solution to a drop of tannin solution as indicator. The tannin solution is prepared by dissolving one part of tannin in 300 parts of water. The first appearance of a yellow colour after adding a drop of lead solution to the tannin solution marks the end of the reaction. The excess of the ammonium molybdate necessary to affect the indicator (generally seven to eighth-tenths of 1 c.c.) must be determined and subtracted from the burette reading. This is done by taking an ammonium acetate solution of about the same strength and acidity, with no lead present; boil and titrate in the usual way, noting the quantity run in before affecting the indicator.

The ammonium molybdate solution contains 9 grms. of the salt per litre, and is standardised upon Kahlbaum's lead sulphate by dissolving in ammonium acetate, and titrating with the conditions as above stated.

To show the importance of prolonged boiling of the lead sulphate with a strong hot solution of ammonium acetate, acid with acetic, the following series of experiments were performed:—Took five different samples, 30 c.c. each, of a standardised lead acetate solution containing 0·010909 grm. of lead per c.c., and added to each portion 10 c.c. of a standardised solution of barium chloride, containing 0·005578 grm. of barium per c.c., then proceeding with each as described in the above method, titrating under the same conditions, but boiling for various lengths of time as indicated below.

	PbA sol.	Ba chloride sol.		Am. molybdate.
1.	30 c.c.	10 c.c.	boiled 2 mins.	30·20 c.c.
2.	,,	,,	,, 5 ,,	30·80 ,,
3.	,,	,,	,, 10 ,,	31·28 ,,
4.	,,	,,	,, 20 ,,	31·30 ,,
5.	,,	,,	,, 40 ,,	31·30 ,,

From the above, since 31·40 c.c. is the theoretical amount, it seems absolutely necessary to boil for at least ten minutes.

Interferences.

The important impurities that might occur in lead ore and so interfere with any of the methods here described are antimony, bismuth, barium, strontium, and calcium. Standard solutions of these elements were made up having the following strengths and compositions as indicated below.

	Grm.	
Barium hydroxide solution ..	0·005578	barium per c.c.
Calcium chloride ,, ..	0·00986	calcium ,,
Strontium ,, ,, ..	0·00984	strontium ,,
Bismuth nitrate ,, ..	0·00931	bismuth ,,
Antimony terchloride ,, ..	0·01005	antimony ,,

In standardising the above solutions the barium was weighed as barium sulphate, the calcium as calcium sulphate, the strontium as strontium sulphate, the solutions of the above three impurities (10 c.c. of each) being evaporated with sulphuric acid to dryness, and the sulphates weighed. The antimony was determined electrolytically, and the bismuth weighed as bismuth trioxide by precipitating as the basic carbonate of bismuth.

The following indicated amounts of the above five solutions were taken with a constant amount of lead acetate solution and carried out exactly as described in the above method with the following results; the theoretical amount of ammonium molybdate after allowing for indicator (eight-tenths of 1 c.c.) is 31·40 c.c.; in the following readings this allowance has been made:—

Antimony.

				Am. molybdate sol.
1.	30 c.c. PbA sol.	2·5 c.c.	Sb chloride sol.	31·40 c.c.
2.	30 ,, ,,	5 ,,	,, ,,	31·38 ,,
3.	30 ,, ,,	10 ,,	,, ,,	31·38 ,,
4.	30 ,, ,,	15 ,,	,, ,,	31·40 ,,
5.	30 ,, ,,	20 ,,	,, ,,	31·55 ,,

Bismuth.

1.	30 c.c. PbA sol.	2·5 c.c.	Bi nitrate sol.	31·40 c.c.
2.	30 ,, ,,	5 ,,	,, ,,	31·38 ,,
3.	30 ,, ,,	10 ,,	,, ,,	31·40 ,,
4.	30 ,, ,,	20 ,,	,, ,,	31·40 ,,
5.	30 ,, ,,	40 ,,	,, ,,	51·38 ,,

Barium.

1.	30 c.c. PbA sol.	0 c.c.	Ba chloride sol.	31·40 c.c.
2.	30 ,, ,,	5 ,,	,, ,,	30·90 ,,
3.	30 ,, ,,	10 ,,	,, ,,	29·20 ,,
4.	30 ,, ,,	20 ,,	,, ,,	27·30 ,,
5.	30 ,, ,,	40 ,,	,, ,,	35·80 ,,

Strontium.

1.	30 c.c. PbA sol.	2·5 c.c.	Sr chloride sol.	31·40 c.c.
2.	30 ,, ,,	5 ,,	,, ,,	31·40 ,,
3.	30 ,, ,,	10 ,,	,, ,,	31·10 ,,
4.	30 ,, ,,	15 ,,	,, ,,	30 35 ,
5.	30 ,, ,,	20 ,,	,, ,,	29·70 ,,

Calcium.

1.	30 c.c. PbA sol.	2·5 c.c.	Ca chloride sol.	31·38 c.c.
2.	30 ,, ,,	5 ,,	,, ,,	31·38 ,,
3.	30 ,, ,,	10 ,,	,, ,,	31·35 ,,
4.	30 ,, ,,	15 ,,	,, ,,	31·38 ,,
5.	30 ,, ,,	20 ,,	,, ,,	31·35 ,,

By using the above method the following results were obtained upon the ores:—

1.	78·74	per cent
	78·82	,,
2.	37·41	,,
	37·44	,,
3.	10·80	,,
	10·83	,,
4.	18·47	,,
	18·51	,,
5.	27·44	,,
	27·35	,,
6.	38 66	,,
	38·58	,,

An attempt was made to improve upon the indicator used, but was without success in so far as reducing the

allowance for the end-point below eight-tenths of a c c. The following compounds were tried as indicators:—Ferrous sulphate and sulphuric acid, sugar, sodium thiosulphate and sulphuric acid, sulphurous acid, thioacetic acid, alkaloids with sulphuric acid (as morphine and narcotine), salicylic acid, potassium ferrocyanide, and ferricyanide. Of the above-mentioned compounds thioacetic acid proved to be the most encouraging as a distinct colour was concerned, but a greater allowance had to be made than with tannin.

E. *Koenig's Method.*

A complete description with details of the method was sent to us by Professor Koenig, of the Houghton School of Mines, where it has been used for a number of years although it has never appeared in any chemical journal. The following method is taken from Professor Koenig's description, which was followed exactly:—

Method.—Take three-tenths to 1 grm. of ore, depending upon the amount of lead contained therein, add 10 c.c. of concentrated nitric acid, and digest at a temperature between 60° and 100° C. until all brown gases have disappeared, and the ore is completely decomposed; this is accomplished more rapidly by frequent shaking or stirring. Pour liquid off, leaving the residue in the beaker, let go to dryness, but not hard dryness. Bring dry residue with 5 per cent sulphuric acid back into the flask, using about 50 c.c., boil for ten minutes, cool, let settle, filter, add again 50 c.c. of 5 per cent sulphuric acid to the precipitate, and decant as before; repeat this operation until about 450 c.c. of 5 per cent sulphuric acid have been used; thus we remove all soluble sulphates. Agitation of the liquid to promote contact with the solids is a vital requirement in order to remove these soluble sulphates. The filter should contain none of the solids. Add 50 c.c. of a 10 per cent solution of ammonium carbonate, let stand for twenty minutes, shaking very frequently, thus converting all the lead sulphate to lead carbonate. Filter through the same filter, and wash thoroughly with cold water until no trace of an alkaline reaction is exhibited in the wash-water.

Place filter-paper with the precipitate in a beaker, add 50 c.c. of a tenth normal nitric acid solution, stir, and digest well at about 50° C. for ten minutes. Add enough methyl orange indicator to produce a distinct red, but no more, and titrate the excess of nitric acid used to dissolve the lead carbonate with a tenth normal sodium hydroxide solution until a yellow colour is obtained.

Modifications.—Results were obtained with equal accuracy and greater rapidity by proceeding with the analysis exactly as in the gravimetric lead sulphate method up to the point where the lead sulphate is dissolved in ammonium acetate, and from that point on proceeding as described by Professor Koenig.

The following are the results as obtained on the ores, and although the results obtained do not vary much, if any, between the modification and the method as described by Professor Koenig, the time required for the manipulation of the modified method was less by about thirty minutes:—

	Prof. Koenig's.		*Modified.*	
1	78·58 per cent	1	78·60 per cent	
	78·62 ,,		78·64	,,
2	37·30 ,,	2	37 38	,,
	37·36 ,,		37·40	,,
3	10·65 ,,	3	10·58	,,
	10·60 ,,		10 62	,,
4	18·40 ,,	4	18·46	,,
	18 34 ,,		18·42	,,
5	27·15 ,,	5	27 24	,,
	27·20 ,,		27·26	,,
6	38·68 ,,	6	38·60	,,
	38·64 ,,		38·68	,,

The effect of the impurities upon the accuracy of the method as carried out in its modification is as follows:—The nitric acid having been calculated in each case from the back titration, the amounts of sodium hydroxide are not recorded.

Antimony.

				Nitric acid sol.
1.	30 c.c.	PbA sol.	0 c.c. Sb chloride sol.	15·80 c.c.
2.	30 ,,	,,	5 ,, ,, ,,	15·82 ,,
3.	30 ,,	,,	10 ,, ,, ,,	15·80 ,,
4.	30 ,,	,,	20 ,, ,, ,,	15·80 ,,
5.	30 ,,	,,	40 ,, ,, ,,	15·80 ,,

Bismuth.

1.	30 c.c.	PbA sol.	2·5 c.c. Bi nitrate sol.	15·80 c.c.
2.	30 ,,	,,	5 ,, ,, ,,	15·80 ,,
3.	30 ,,	,,	10 ,, ,, ,,	15·78 ,,
4.	30 ,,	,,	20 ,, ,, ,,	15·82 ,,
5.	30 ,,	,,	40 ,, ,, ,,	15·80 ,,

Barium.

1.	30 c.c.	PbA sol.	2·5 c.c. Ba chloride sol.	16·32 c.c.
2.	30 ,,	,,	5 ,, ,, ,,	16·50 ,,
3.	30 ,,	,,	10 ,, ,, ,,	17·38 ,,
4.	30 ,,	,,	20 ,, ,, ,,	18·43 ,,
5.	30 ,,	,,	40 ,, ,, ,,	19·22 ,,

Calcium.

1.	30 c.c.	PbA sol	2·5 c.c. Ca chloride sol.	15·85 c.c.
2.	30 ,,	,,	5 ,, ,, ,,	16·00 ,,
3.	30 ,,	,,	10 ,, ,, ,,	18·40 ,,
4.	30 ,,	,,	20 ,, ,, ,,	23·35 ,,
5.	30 ,,	,,	40 ,, ,, ,,	26·80 ,,

Strontium.

1.	30 c.c.	PbA sol.	2·5 c.c. Sr chloride sol.	16·88 c.c.
2.	30 ,,	,,	5 ,, ,, ,,	17·50 ,,
3.	30 ,,	,,	10 ,, ,, ,,	21·50 ,,
4.	30 ,,	,,	20 ,, ,, ,,	25·50 ,,
5.	30 ,,	,,	40 ,, ,, ,,	28·88 ,,

F. *Oxalate or Permanganate Method.*

This method was first described by Hempel, then it was modified by Low as described in the *Journ. Am. Chem. Soc.*, October, 1893, also modified afterwards by Haswell, Crook, and Knight.

This method was carried out as follows, according to Low:—Decompose the ore, and wash precipitate of lead sulphate, calcium sulphate, &c., as described in the gravimetric lead sulphate method already given. Collect the precipitate of lead sulphate in a beaker free from filter-paper, and treat with 50 c.c. of a cold semi-saturated solution of ammonium chloride. Stir the mixture to dissolve as much as possible of the lead sulphate, and decant off the clear liquid; dissolve any lead sulphate in the residue with a few c.c. of a strong solution of sodium hydroxide, and heating to boiling. To this solution add sufficient dilute sulphuric acid to cause most of the lead to precipitate, avoiding an excess, and rinse back into the beaker containing the chloride solution. Place in the flask pieces of sheet aluminium, and boil for five minutes, whereupon all the lead is precipitated. Dilute with cold water, and decant, wash to remove chlorides. Finally, to the lead and aluminium in the flask add 5 c.c. of a mixture of one part strong nitric acid and two parts of the distilled water, and warm gently. The lead is all dissolved, wash and remove all the aluminium strips, add to the solution a few drops of phenolphthalein solution, and then a very slight excess of strong sodium hydroxide. Now add 10 c.c. of a cold saturated solution of oxalic acid. Cool if warm, filter, and wash thoroughly with cold water. In a beaker have heating about 75 c.c. of distilled water and a few c.c. of strong sulphuric acid; drop filter-paper and precipitate of lead oxalate into this solution, and titrate at once with permanganate. The factor for the iron times 1·888 gives the factor for lead.

Notes.—The method gave very poor results on the ores, as is shown by the following analysis of the ores; in fact the results were so inaccurate that the method was at

once condemned and the effect of impurities were not determined.

1.	77·54	per cent
	77·60	,,
2.	36·71	,,
	36·62	,,
3.	9·92	,,
	9·98	,,
4.	17·54	,,
	17·65	,,
5.	26·28	,,
6.	37·38	,,

The chief trouble seems to be in the fact that the lead falls from the aluminium foil, thus going slowly in solution and being lost; therefore larger sheets of aluminium should be used. Besides there seems to be a constant galvanic action going on between the solution and the aluminium which also takes lead into solution. The solubility of lead oxalate is objectionable; this can be somewhat overcome by the use of ethyl alcohol, concentrated solution, and a large excess of oxalic acid. The method is exceedingly long and troublesome, requiring about two and one-quarter hours time for its manipulation. The great care required in washing the oxalate precipitate, the inconvenience of precipitating and washing the spongy lead (a modification which in most ores seems unnecessary) and other details of manipulation seem to more than offset the advantage of an inside indicator.

Crook's modification was to obtain the acetate solution as in the gravimetric lead sulphate method as already described, and then precipitate the oxalate directly with an excess of oxalic acid, and the excess of oxalic acid titrated with standard potassium permanganate after making the solution acid with sulphuric acid.

Knight's modification was to obtain the lead sulphate as usual and dissolve it in boiling dilute hydrochloric acid and filtered if much silica or barium sulphate is present, the solution diluted to 100 c.c., and the lead precipitated by granular zinc. The metallic sponge of lead is then washed with cold water, and dissolved in nitric acid, the acid neutralised with sodium carbonate, the precipitate dissolved in strong acetic acid, alcohol added, and the lead precipitated with oxalic acid. It is then filtered and washed, and the precipitate dissolved in strong sulphuric acid, and the freed oxalic acid titrated with potassium permanganate.

(To be continued).

Substitution of Fluorine for Oxygen in Iodylised Compounds.—R. F. Weinland and W. Stille.—The authors, in conjunction with M. Lauenstein (*Berichte*, vol. xxx., p. 866), showed that an iodate, such as IO_3K, for example, treated with hydrofluoric acid gives IO_2Fl_2K. The iodylised compounds of M. Willgerodt (*Berichte*, vol. xxvi., p. 357), that is to say those resulting from the substitution of an organic radical for the OH in IO_3H, behave in the same manner. If, for example, we make a hot saturated solution of iodylobenzene $C_6H_5IO_2$ in hydrofluoric acid at 40 per cent, on cooling we obtain silky needles, or sometimes large, flattened prisms, which can be drained in a funnel on platinum gauze; these crystals are fairly stable in dry air, but decompose easily in moist air; they are decomposed by water into hydrofluoric acid and iodylobenzene, and if heated to 216° they decompose, often with violence. This body is fluoiodylobenzene, $C_6H_5IOFl_2$. In the same manner the ortho- and para-fluoiodylotoluenes, $C_6H_4(CH_3)IOFl_2$, can be prepared; the former is in small lamellary crystals, fusible at 120°, decomposing at 170—190°; the latter in beautiful crystals detonating at 198—206°.—*Berichte*, vol. xxxiv., p. 2631.

NOTICES OF BOOKS.

Quantitative Analysis. By Alexander Classen, Director of the Laboratory of Inorganic Chemistry and Electro-Chemistry in the Royal Technical School, Aachen. Authorised Translation from the Fifth German edition, with an Appendix on the Qualitative Analysis of Minerals, Ores, Slags, Metals, Alloys, &c., including the Rare Elements. By Norman F. Harriman, Assistant in Chemistry in the University of Michigan. With seventy-nine illustrations. Ann Arbor, Michigan: George Wahr, Publisher and Bookseller. 1902. Pp. viii., 540. 8vo. Ill.

The instructive writings of Professor Classen on methods in analytical chemistry have been before the public for nearly thirty years, his first publication ("Grundriss der Analytischen Chemie," Bonn, two vols.) being dated 1873, and passing to a second edition six years later. His "Handbuch der Analytischen Chemie," which appeared in two parts, one of qualitative and one of quantitative analysis, has also been through several editions in its original language as well as in translations into English, French, Polish, and Russian. Besides these, "Classen's Treatise on Electrolytic Methods in Analytical Chemistry," is well known in three languages.

The English version of the second part of his Handbuch, published in 1878, having been long out of print, Professor Harriman has been induced to prepare the present volume.

One of the features of Classen's book that makes it well adapted to the needs of those beginning the study of quantitative analysis, is the practical arrangement of the subjects treated; after a chapter on general operations, the author takes up first crystallisable salts, then alloys and minerals, and eventually advances to ores, slags, waters, &c., of increasing difficulty. The instructions in each example are very clear, being the result of long experience as a teacher and as an expert analyst. The section on pig-iron, steel, spiegeleisen, ferromanganese, &c., seems to be quite full, occupying forty pages; an equal number of pages is occupied with potable water and mineral waters, while the section on organic analysis is rather brief, as might be expected in a work of this description.

Volumetric analysis is treated separately (pp. 407—459), but the methods in this section are often referred to in the body of the work. Qualitative methods, with special reference to minerals, ores, slags, metals, and alloys, are described in a voluminous appendix. The volume closes with several useful tables and a full index.

The translator has done his share of the work with linguistic skill born of familiarity with German and an appreciation of the requirements of good English. He has strengthened the volume by introducing some processes that had been overlooked by the German author, notably the method for the proximate analysis of coal recommended by the Committee of the American Chemical Society, Handy's rapid volumetric method for phosphorus in pig-iron (titration of the phosphomolybdate precipitate), and some of the methods of that eminent expert on rock analysis, Dr. W. F. Hillebrand, of the U.S. Geological Survey, whose "Bulletin" is frequently cited.

While the volume contains no surprising novelties it will be found none the less usable on that account, and can be cordially commended to those needing a thorough work in instructing classes. Its clearly printed large pages make the book somewhat bulky, but it lies open well on a work-table; its illustrations are well chosen and sufficient for the purpose. H. C. B.

Physikalische Chemie der Zelle und der Gewebe. ("The Physical Chemistry of Cells and Tissues"). By Dr. Rudolf Höber. Leipzig: Wilhelm Englemann. 1902.

Owing to the rapid advances which are continually being made in the applications of physical chemistry in the

regions of physiology, it becomes more necessary every day for the physiologist to have a thorough and extensive knowledge of this branch of his subject. This book contains all that could be required for this purpose, and is in many respects an excellent work. A very clear and lucid exposition of the theory of ionisation will be found eminently worthy of careful reading, and the same may be said of the chapters on the theory of osmosis. If occasionally statements which should still be regarded as disputable are made in too definite language, as if their truth had been established beyond a doubt, the bold treatment of the whole subject atones for this characteristic defect.

Die Darstellung des Chroms und seiner Verbindungen mit Hilfe des Elektrischen Stromes ("The Preparation of Chromium and its Compounds by the Aid of the Electric Current"). By Dr. Max Le Blanc. Halle-a-S.: Wilhelm Knapp. 1902.

This is the third volume of the new series of monographs of applied electro-chemistry, and deals with the preparation of chromium and its compounds. In the preface the author alludes to the impossibility of making any report perfectly complete, however great the care bestowed upon it; it is obvious, however, from a perusal of this work, that every effort has been made to render it as comprehensive as possible, special attention having been devoted to the patent literature on the subject, which evidently has been carefully studied and most judiciously sifted to discover innovations of real importance, the main object being to obviate the necessity for frequent reference to original papers. The general plan and arrangement of the book are very similar to those of the preceding volumes of the series.

Die Chemische Industrie des Deutschen Reiches im Beginne des XX. Jahrhunderts. ("The Chemical Industries of Germany at the beginning of the Twentieth Century.") By Dr. Otto N. Witt. Berlin: Julius Sittenfeld. 1902.

The aim of this volume is twofold; firstly to summarise the state of the chemical industries of Germany at the beginning of the present century, with special reference to the part played by German chemical manufacturers in the Paris Exhibition of 1901, and secondly to commemorate the twenty-fifth anniversary of the founding of the "Verein zur Wahrung der Interessen der Chemischen Industrie Deutschlands," which sprang into existence in Frankfort in 1877, and celebrated its jubilee in September, 1902. The history of the growth in magnitude and importance of this society is closely bound up with the history of the chemical industries themselves, the interests of which it has done much to further. The book contains brief surveys of the present condition of the more important industries, together with short historical notices and copious statistics. Modern manufacturing processes are described as fully as space allows. The difficulties surrounding the judicious selection of the facts and details to be mentioned to the exclusion of others of apparently very nearly the same general interest and importance, are very great, but have as far as possible been surmounted in this volume, from which may be obtained a very clear idea of the present state of the German chemical industries.

Jahrbuch der Elektrochemie, VIII. Jahrgang. ("Annual of Electrochemistry, VIII. Year"). Edited by Dr. Heinrich Danneel. Halle, A.-S.: Wilhelm Knapp. 1902.

This is the eighth annual report on Electrochemistry, and is for the first time edited by Dr. Heinrich Danneel. No alteration has been made in the scheme or scope of the annual, though it has necessarily become somewhat more bulky, owing to the constantly increasing number of innovations and fresh processes and other developments of the subject, which cannot be allowed to pass by unnoticed. The report aims at being something more than a mere historical review, and sound criticism finds a considerable place in it. The editor has been aided in his task by distinguished collaborators, especially in the section devoted to Applied Electrochemistry. The part which deals with the purely scientific aspects of the subject has been written mainly by Dr. Danneell himself; it contains abstracts of papers of importance which have appeared during the year, together with critical notices of the most recently published books on Electrochemistry. Improvements and innovations in apparatus and instruments are also described. The section on the applied science contains copious lists of patents and is fully illustrated by diagrams; it also contains a complete list of recent books and articles bearing on the subject. Though not unnaturally the work of German chemists receives the greatest amount of attention, somewhat to the exclusion of those of other nationalities, the annual gives on the whole a comprehensive and satisfactory view of modern work in the region of Electrochemistry.

Jena Glass and its Scientific and Industrial Applications. By Dr. H. Hovestadt. Translated and edited by J. D. Everett, M.A., F.R.S., and Alice Everett, M.A. London: Macmillan and Co., Ltd. New York: The Macmillan Company. 1902. Pp. 419.

The Jena glass works owe their existence to the increasing demand for excellence in refracting instruments. Abbe pointed out in 1876 that since Daguet's glass-works were closed there were only two establishments left which supplied public demands, as the third one (the only one in Germany), founded by Utzschneider and Fraunhofer, was still in the exclusive service of one optical firm. As a result of these remarks Schott communicated with Abbe, and in 1881 they commenced a joint investigation of the difficult problem of how to improve optical glass.

The first meltings were very small—not more than 2 to 30 grms.—and were directed solely to the purpose of studying all chemical elements that could enter in any form into the composition of glasses, as regards their influence on refractive power and dispersion; thus a series of facts was ascertained which gave hopes of obtaining new kinds of glass, better for some purposes than ordinary crowns and flints. Some of the problems it was desired to solve were to obtain glasses of the same mean refractive index and very various dispersions, and glasses of the same mean dispersion and very varying refractive indices. The practical realisation of this must be expected to take place gradually, but very tangible results were already obtained in 1883.

When Abbe and Schott began their experiments there were only five glass-forming oxides whose optical effects were well known, but they gradually increased this number until twenty-eight new elements were introduced in quantities of at least 10 per cent. It was soon seen that by the introduction of new elements variation of the hitherto fixed relation between refraction and dispersion could be attained, and fluorine was found to be a most advantageous element to use, since, besides lengthening the blue end of the spectrum, it lessens the dispersion throughout the middle portion. As the Jena glass works have gradually developed, other branches of manufacture have been taken up, and glasses characterised by special powers of withstanding heat and chemical action have been produced; but in this regard we are sorry to notice a great falling off in the quality of glass during the last two or three years.

The Jena glass beakers we have had lately are in no way better than ordinary Bohemian glass, numbers of them crack simply through having water boiled in them; and though we were so well satisfied with them five or six years ago, we have been obliged lately to discontinue their use owing to the large number of breakages, and have returned to the use of ordinary Bohemian glass.

The bulk of this volume is of a decidedly mathematical character, and deals with optical systems, the mechanical, thermal, and optical properties of glass; after-working and thermometry; the chemical behaviour of glass surfaces; electric and magneto-optic properties of glass, &c.

The appendix contains a revised list of Jena optical glasses, and there are a number of additional notes on coloured glasses, Durax glass for gauge-tubes, influence of temperature on thermal conductivity, and the optical effects of stress, &c.

There is a short list of errata which must not be overlooked, and a good table of contents and an index.

Gas Analysis' Manual. By JACQUES ABADY, M.Inst.M.E. Incorporating F. W. Hartley's "Gas Analysts' Manual," and "Gas Measurement." London: E. and F. N. Spon, Ltd. New York: Spon and Chamberlain. 1902. Pp. 561.

THOUGH the two above-mentioned books are incorporated in this volume, it will be found that the larger proportion of matter is new work, the bulk of Mr. Hartley's books being found in Chapters I., XI., and XII., which deal with "Photometry," "Meter Testing Apparatus," and "Meter and Governor Testing."

This volume is divided into twelve chapters, and an appendix containing a number of tables useful for working out results. As already mentioned, Chapter I. is on photometry, and describes with great detail the methods in vogue for making photometric tests, while emphasis is laid on the necessity for the periodical re-verification of standardised instruments. With regard to standards of light, the standard laid down by Act of Parliament for the United Kingdom, except London, is the well-known standard sperm candle, burning 120 grains per hour. Personally, we prefer any other standard light to this one; the "standard candle" is one of the most variable sources of light. The standard of light adopted in London is Harcourt's 10-candle pentane lamp, by which excellent results can be secured.

Of late years circumstances have arisen in connection with the manufacture and distribution of gas, differing in many respects from those of a few years ago.

Formerly, the principal use to which gas was put was to produce a luminous flame, but now heating power is becoming an important factor, not only for cooking purposes, but also for furnishing light by heating incandescent mantles; hence more attention is being paid to the calorific value of gas, and the most important question for the consideration of gas makers is how to produce a gas of adequate calorific power which will at the same time satisfy the statutory requirements as to lighting power. This subject is dealt with in Chapter IV. on calorimetry and specific gravity, and includes a note upon "Mond" gas.

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Chapter V. is on "The Referee's Test for Sulphur and Ammonia in Gas," and includes a full description of the apparatus used and the details of carrying out the tests. Chapter VI. is on "Coal Testing," and Chapters VII. and VIII. describe the various tests for enrichment, purification materials, and purity tests for the gas in various stages of manufacture.

The by-products from gas making have always been a most important item; these are dealt with in Chapter IX., while in Chapter X., which is one of the most useful in the book from the practical point of view, we find all the operations of technical gas analysis as are ordinarily in use in a gas-works. The complete analysis of such a complex mixture as illuminating gas is a most intricate operation, and does not come within the scope of routine gas examination; the methods in general use in gas-works are those necessitating the use of Elliott's or Hempel's apparatus, while the analysis of furnace gases is made either by Orsat Muencke's or by Bunte's apparatus.

The book is of undoubted value, and unites a large amount of hitherto scattered information in one volume. The index especially is to be recommended, and fills 35 pages.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxv., No. 26, December 29, 1902.

Presence of Argon in Gases from the Bordeu Spring at Luchon, and presence of Free Sulphur in the same Sulphurous Waters.—Henri Moissan.—The author makes a quantitative analysis of the gases issuing from the Bordeu Spring at Luchon, and finds that they contain 2·56 per cent of argon in which there is no helium. Further experiments prove that the water of the grotto contains sulphur in solution.

A New Preparation of Silicon Hydride, Si_2H_6.—Henri Moissan.—When lithium silicide is gently heated in a current of dry hydrochloric acid gas, a certain amount of hydrogen is produced as well as chlorides of lithium and silicon. If, on the contrary, a concentrated solution of hydrochloric acid, $(HCl+2H_2O)$, is allowed to act slowly on the lithium silicide, siliciuretted hydrogen, Si_2H_6, is formed in abundance, and this can be condensed by allowing it to pass into liquid air at $-200°$.

Emanations from Phosphorus.—Eugène Bloch.—The conducting power of dry air when passed over phosphorus is due to ions of very weak mobility, which serve as nuclei of condensation for water vapour, even when the air is not saturated. The author puts aside for the moment the question of the chemical mechanism by which these ions are produced, and if their formation is allied to that of a definite compound, such as ozone or an oxide of phosphorus, or if it is due to a simple modification of the oxygen. This question is evidently connected with the precise chemical examination of the oxidation of phosphorus, on which subject a great deal of further research is necessary.

Spectrum of Flame.—C. de Watteville.—Flame spectra may be divided into two classes, those of pure calorific origin and those of electric as well as calorific origin. The study of the former has lately been neglected. The author examines the spectra of the two principal regions of a flame, the interior cone and the flame proper which surrounds this. His researches are made on flames formed by the combustion of a mixture of inflammable gases, and also of air charged with powders of metallic salts.

Proportion of Hydrogen in Atmospheric Air.—Anatole Leduc.—This paper is an answer to M. Gautier's discussion on the relative proportion of hydrogen in atmospheric air. The author re-investigates the matter, and finds no reason to change his former opinion.

Thermic Examination of Metaphosphoric Acid.—H. Giran.—The author measures (1) the quantity of heat evolved during the transformation of metaphosphoric acid into orthophosphoric acid by a method identical with that already employed to examine the transformation of pyrophosphoric acid into orthophosphoric acid, *i.e.*, by the

action of sulphuric acid (*Comptes Rendus*, vol. cxxxv., p. 961); (2), the heat of solution of solid metaphosphoric acid prepared by the calcination of PO_4H_3; (3), the heat of solution of fused sodium metaphosphate (Graham's soluble metaphosphate); (4), the heat of neutralisation of metaphosphoric acid by soda.

Certain Sources of Mineral Gases.—Ch. Moureu.—(See p. 38).

Cryoliths. — E. Baud. — The author prepares the hydrated sodium cryolith, the hydrated potassium cryolith, and the double ammonium fluoride, and in each case finds their heats of precipitation. He also examines the natural anhydrous cryoliths, and finds their heats of formation. The knowledge of the heat of formation of the sodium cryolith and that of anhydrous fluoride of aluminium is indispensable in the metallurgy of aluminium when it is necessary to calculate the quantity of electric energy necessary to decompose the cryolith.

A New Method of Estimating Hydroxylamine Volumetrically.— L. J. Simon.— The author believes that up to the present time there has been no satisfactory method of estimating hydroxylamine, and so he devises a volumetric estimation founded on the particular action of permanganate of potash on the oxalate of hydroxylamine. The latter is a well crystalline and anhydrous salt, which can easily be obtained in a pure state owing to its slight solubility in water. The action takes place in two phases, the first being expressed by the equation—

$$2MnO_2K+4[C_2O_4H_2(NH_2OH)] = 2C_2O_4Mn+2C_2O_4KH+N_2O+6N+15H_2O,$$

and in the second phase in presence of sulphuric acid the oxalic acid is oxidised in the ordinary manner, evolving carbon dioxide. Very good results were obtained by this method.

Composition and Constitution of Sulphohydrated Hydrates.—M. de Forcrand.—In 1882 the author discovered a series of mixed hydrates to which he attributed the uniform composition $M+2H_2S+23H_2O$; M being a volatile halogenated organic compound analogous to the simple ethers of the fatty series. H_2S can also be replaced by H_2Se. He further develops this research, and proves that all these compounds are formed by the union of two simple hydrates, $(M+mH_2O)+2(H_2S+m'H_2O)$; m' being probably 6, since the formula of the simple hydrate of sulphuretted hydrogen is H_2S+6H_2O.

Metho-ethenylbenzene Di-bromide.—M. Tiffeneau.—Dibromomethoethenylphene, $C_6H_5—CBr(CH_3)—CH_2Br$, when acted upon by alcoholic KOH loses 1 molecule of HBr, giving the compound C_9H_9Br, which corresponds to one of the two formulæ:—(1) $C_6H_5—C(CH_2Br)=CH_2$, or (2) $C_6H_6—C(CH_3)=CHBr$; the second being proved the correct one on account of its action with Mg and Na. The author examines the properties of this substance.

Synthesis of a derived Aromatic Carbide of Camphor.—C. Chabrié.—By heating chloride of camphor with benzene and using many precautions, finally an oily liquid separates. Amongst the compounds contained in this liquid the author isolates an almost colourless substance, passing over at about 315°, and whose composition corresponds to the formula $C_{16}H_{18}$, and is formed according to the reaction $C_{10}H_{15}ClO+C_6H_6=C_{10}H_{13}.C_6H_5+H_2O+HCl$. He intends to further investigate this aromatic derivative of camphor and the other products formed at the same time.

Decomposition of certain Di- and Tribasic Organic Acids.—MM. Œchsner de Coninck and Raynaud.—The authors examine the decomposition products of malonic, succinic, tartaric, malic, and citric acids. The decomposition is effected methodically by heating them with glycol, glycerin, or sulphuric acid.

A Method of Transforming the Monochlorated and Monobromated Derivatives of the Hydrocarbons into Mono-iodated Derivatives.—F. Bodroux.—When small portions of iodine are added to an ethereal solution of a chloride and bromide of alcoyl-magnesium, the iodine rapidly disappears, and the solution becomes heated. The reaction takes place between a molecule of the organo-metallic compound and a molecule of iodine, a double salt of magnesium and an iodine derivative resulting, $\begin{matrix}R\\Br\end{matrix}>Mg+I_2=RI+Mg<\begin{matrix}I\\Br\end{matrix}$. The author applies this reaction to the aromatic series.

Bulletin de la Société Chimique de Paris.
Series 3, Vol. xxvii., No. 11.

Estimation of Thallium in the Thallous State.—V. Thomas.—Already inserted.

Action of Bromine on Thallous Chloride in the presence of Water; Compounds of the Type Tl_2X_4.—V. Thomas.—Already inserted.

Chlorobromides of Thallium. Compounds of the Type Tl_4X_6.—V. Thomas.—Already inserted.

Action of Bromine on Thallous Chloride in the presence of Organic Solvents and in the Dry Way.—V. Thomas.—Already inserted.

Constitution of Tariric Acid.—A. Arnaud.—Already inserted.

The Nature and Properties of the Bodies formed in the Action of Chloroform on Naphthol β.—R. Fosse.—A long paper of 42 pages, mostly constitutional formulæ; unsuitable for abstraction.

Action of Hydroxylamine on some Halogen Derivatives of Methylphenylketone.—A. Collet.—The action of hydroxylamine on the halogen ketones gives halogen monoximes or dioximes, according to the conditions of the experiment. By using the method described by MM Korten and Scholl, the author has prepared the oximes of some other derivatives of methylphenylketone. He has also examined the action of hydroxylamine on a boiling alcoholic solution of the ω-monobromised and ω ω-dibromised derivatives of methyl-*p*-chlorophenylketone and of methyl-*p*-bromophenylketone; in these two cases he obtained the *p* chlorophenylglyoxime and the *p*-bromophenylglyoxime. The author has also prepared directly a certain number of the halogen-ketoximes, by reacting with the chlorides of chloracetyl and bromacetyl on para-chlorised or para-bromised aniline. The reaction is very lively, but can be made more quiet by diluting with sulphide of carbon. The products were purified by several crystallisations in boiling alcohol. They are in the form of colourless crystals, soluble in warm alcohol, but only slightly soluble in the cold; their fusing-points are:—

Chloracetanilide *p*-chlorised	167—168°
Chloracetanilide *p*-bromised	179—180°
Bromacetanilide *p*-chlorised	161°
Bromacetanilide *p*-bromised	168—169°

Crystallographic Properties of Benzylidene, Methyl and Ethylsalicylidene, and Anisal Camphors and their Products of Reduction.—J. Minguin.—The author gives the crystallographic properties of the above products and of some of their derivatives.

The Solubility of some Soft Resins.—Ch. Coffignier.—The resins were treated in two different manners; in one case 10 grms. of the resin were wrapped in Schleicher paper, and exhausted for five hours in a Soxhlet apparatus; in the second case 10 grms. of the resin were treated with 55 c.c. of a solvent for an hour at boiling-point, in a flask fitted with a vertical condenser; the insoluble portion was filtered off and washed with 100 c.c. of the solvent used. The details of the experiments made with various resins are given at length.

The Coefficient of Impurities of Brandies.—A. Cardoso-Pereira.—The results of numerous analyses made in the municipal laboratory of Paris show that commercial alcohols and wine-brandies have average coefficients of impurity of 0·0176 and 0·5184. Other

chemists have stated that the figure for wine-brandies is never lower than 0·300.

New Reducing Diastase extracted from Koji-japonais, and Secreted by "Eurotium Orizoe"; Jacquemose.—E. Pozzi-Escot.—This diastase, known by the name of "Koji" or "Taka," is met with commercially in two forms; the first, in tabloids, consists entirely of "Koji" or Japanese yeast; the second, in the form of an amorphous, yellow powder soluble in water, is "taka-diastase," or the active principle of Koji extracted by means of alcohol. The author has extracted a new diastase from Koji, having the same reducing power as *philothion*, but not possessing any hydrogenising properties with regard to sulphur; he proposes the name *reductase* for this series of products.

MISCELLANEOUS.

Preparation of Chlorine by means of Permanganates.—C. Graebe.—The author has experimented with both commercial and crystallised permanganate of potassium, as well as with permanganate of calcium, which is easily soluble. As a result of his experiments, he finds that when it is required to prepare small quantities of chlorine, the use of permanganate is very convenient, especially in cases where the presence of peroxide of chlorine would be objectionable; for its preparation on a large scale, the chlorate of soda method is preferable when the presence of the peroxide is not of importance. To prepare chlorine by means of permanganate, the same apparatus is used as with the chlorate of sodium method; solid permanganate is placed in a flask, and concentrated hydrochloric acid is dropped on to the salt very gradually. The operation is commenced in the cold, then heat is applied when half the necessary amount of hydrochloric acid has been added. To get off all the chlorine, it is necessary to use an excess of hydrochloric acid, and experience shows that about 10 molecules of acid are necessary for each 1 of permanganate instead of the 8 required theoretically. When the operation is properly carried out, almost the theoretical amount of chlorine is obtained.—*Berichte*, vol. xxxv., p. 13.

The Formation of Dithionic Acid.—J. Meyer.—The author explains the preparation of the dithionates in the following manner:—The action of SO_2 on MnO_2 does not at first produce either free dithionic acid or MnO, or sulphate of binoxide of manganese, but instead manganic sulphite (of the sesquioxide) and free oxygen; the manganic sulphite is then split up into dithionate and manganous sulphite—

$$2MnO_2+3SO_3H_2=(SO_3)_3Mn_2+3H_2O+O.$$
$$(SO_4)_3Mn_2=S_2O_6Mn+SO_3Mn.$$

In fact, he has observed analytically the presence of sulphite in the products of the reaction done in the cold. If this interpretation is correct, the hydrates of the sesquioxides (being able to form protoxides) of iron, cobalt, and nickel, suspended in water, and treated with a current of SO_2 at about 0°, ought to form first a sulphite of the sesqui-oxide, which will then decompose as above into hyposulphate and sulphite of the protoxide. Experiments have shown that this is the case. For instance, with $Fe_2(OH)_6$, we first obtain a deep red liquid (ferric sulphite), which soon becomes decolourised and gives a very good yield of dithionate. On the other hand, PbO_2 does not react on SO_2 in the presence of cold water; HgO is the same. As for the other binoxides, BaO_2, MgO_2, Na_2O_2, and H_2O_2, when treated with SO_2, they give H_2SO_4 directly in the cold. The examination and study of the electric conductivity and the cryoscopy of the solutions of dithionates, confirm the opinion that the molecule of dithionic acid is indeed $S_2O_6H_2$.—*Berichte*, vol. xxxiv., p. 3606.

MEETINGS FOR THE WEEK.

TUESDAY, 27th.—Royal Institution, 5. "The Physiology of Digestion," by Prof. Allan Macfadyen, M.D.

WEDNESDAY, 28th.—Society of Arts, 8. "The Cost of Municipal Trading," by Dixon H. Davies.

THURSDAY, 29th.—Royal Institution, 5. "Pre-Phœnician Writing in Crete, and its Bearings on the History of the Alphabet," by A. J. Evans, F.R.S.

FRIDAY, 30th.—Royal Institution, 9. "Vibration Problems in Engineering Science," Prof. W. E. Dalby.

SATURDAY, 31st.—Royal Institution, 3. "The Bi-centenary of Samuel Pepys—His Musical Contemporaries, Criticisms, and Compositions" (with Musical Illustrations), by Sir Frederick Bridge, M.V.O., Mus.Doc.

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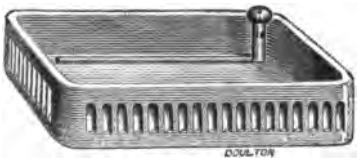

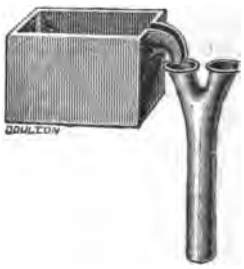

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CHEMICAL NEWS

AND

JOURNAL OF PHYSICAL SCIENCE

Edited by Sir Wm Crookes, F.R.S. (WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE") *Established Fifty-eight Years.*

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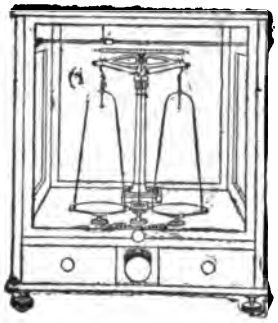

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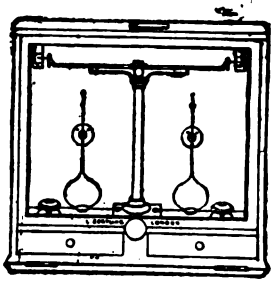

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THE CHEMICAL NEWS.

Vol. LXXXVII., No. 2253.

REVISION OF THE ATOMIC WEIGHT OF LANTHANUM.*

By BOHUSLAV BRAUNER, Ph.D., and FRANTIŠEK PAVLÍČEK,† Bohemian University, Prague.

The atomic weight of lanthanum belongs to those constants which have been relatively often determined. It is seen from Table I., given below, that since the year 1842, twenty-six series of determinations have been made by fifteen chemists, whereas in the case of, for example, the technically important iron, we possess only seven determinations. But whereas the numbers obtained for iron are all approximate to 56, those obtained for lanthanum differ considerably from one another, the minimum being La = 132·55 and the maxium La = 148·25 (difference = 15·7), and if we take into account only the most trustworthy determinations made within recent times, we have a minimum of 135·0 and a maximum of 139·7, the difference being 4·7.

In Table I., the first column contains the name of the chemist, and the numbers in brackets show that several determinations were made by the same chemist. The second column gives the date of publication, the third column indicates shortly the method used and the ratio from which the atomic weight was calculated. The last column gives the resulting "atomic numbers" with regard to O = 16. The numbers were calculated from the data contained in the classical work of Clarke ("A Recalculation of the Atomic Weights," Revised Edition, Washington, 1897). With regard to O = 16 and S = 32·07, used by Clarke, on using the international S = 32·06, which was used for the calculation of the results obtained in the present paper, the numbers of the table depending on the atomic weight of sulphur would be reduced by 0·02.

The last lines of the table contain the mean values, as calculated by different chemists, for their atomic weight tables.

The abnormally low number, La = 135, which appears several times in the table, is not without some historical interest.

In 1870, Mendeléeff was of opinion that the quadrupled equivalent of lanthanum, $\frac{135}{3} \times 4 = 180$, represented its true atomic weight, and that the element belonged to the fourth group.

The determination of the specific heat of metallic lanthanum by Hillebrand, in 1874, proved that the order of the atomic weight of lanthanum is 138, but in spite of this Winkler, in 1891 (*Ber.*, xxiv., 889), considered that the composition of lanthanum hydride prepared by him is best represented by the simple formula LaH_2, if we assume $La^{IV} = 180$.

I have shown (*Ber.*, 1891, xxiv., 1328) that the atomic weight of lanthanum cannot differ much from $La^{III} = 138·2$, and that the hydride has the formula La_2H_3, which is analogous to that of the hydride of the quadrivalent cerium, Ce_2H_4. On examination of the spark spectrum of the fractions of lanthanum material yielding the apparent atomic numbers 132 to 135, I found that these low numbers are due to the admixture of yttrium (Y = 89).

In 1898, on examining the solubilities of the oxalates of some rare earths in normal sulphuric acid, I found that that of yttrium appproaches that of lanthanum, so that on fractionating with oxalic acid certain lanthanum fractions may contain an admixture of yttrium.

Although it was thus proved by me that the low

* From the *Transactions of the Chemical Society*, 1902, vol. lxxxi.
† Read Pavleetchek.

TABLE I.—*Determinations of the Atomic Weight of Lanthanum.*

Chemist.	Date.	Method and ratio used.	La (O = 16, S = 32·07).
Rammelsberg	1842	$La_2(SO_4)_3 : 3BaSO_4$	132·55
Marignac (1)	1849	$La_2(SO_4)_3 : 3BaSO_4$ (A)	139·53
Marignac (2)	1849	$La_2(SO_4)_3 : 3BaSO_4$ (B)	148·25
Marignac (3)	1849	$La_2(SO_4)_3 : 3BaCl_2$	141·27
Holzmann (1)	1858	$La_2O_3 : 3BaSO_4$	139·46
Holzmann (2)	1858	La_2O_3 in $La_2(IO_3)_6,3H_2O$	137·59
Holzmann 3)	1858	La_2O_3 in $La_2Mg_3(NO_3)_{12},24H_2O$	138·68
Czudnowicz	1860	$La_2O_3 : 3BaSO_4$	133·00
Hermann (1)	1861	$LaCl_3 : Cl_3$	139·25
Hermann (2)	1861	$La_2(SO_4)_3 : La_2O_3$	139·52
Hermann (3)	1861	$La_2O_3 : 3CO_2$	139·36
Zschiesche	1868	$La_2(SO_4)_3 : La_2O_3$	135·35
Erk (1)	1871	$La_2(SO_4)_3 : La_2O_3$	135·65
Erk (2)	1871	$La_2(SO_4)_3 : 3BaSO_4$	134·79
Marignac (4)	1873	$La_2(SO_4)_3 : La_2O_3$	138·81
Cleve (1)	1874	$La_2O_3 : La_2(SO_4)_3$	139·29
Brauner (1)	1882	$La_2O_3 : La_2(SO_4)_3$	138·88
Brauner (2)	1882	$La_2O_3 : La_2(SO_4)_3$	138·36
Cleve (2)	1883	$La_2O_3 : La_2(SO_4)_3$	138·36
Bauer	1884	$La_2O_3 : La_2(SO_4)_3$	138·77
Bettendorff	1892	$La_2O_3 : La_2(SO_4)_3$	138·71
Gibbs and Shapleigh	1893	$La_2O_3 : 3C_2O_3$ and $La_2O_3 : La_2(SO_4)_3$	139·71
Schützenberger	1895	$La_2O_3 : La_2(SO_4)_3$. Principal fraction	138·0
Schützenberger	1895	$La_2O_3 : La_2(SO_4)_3$. Side fraction	135
Muthmann	1899	?	138·4 ?
Atomic Weight Tables—			
Clarke	1897	"Recalculation," mean	138·64
Clarke	1897	Cleve's and Brauner's numbers only	138·36
Clarke	1901, 1902	American Commission Reports for 1900, 1901	138·6
International	1902	German Chemical Society Commission	138
Richards	1901	Own table	138·5

numbers of about 135, obtained for the atomic weight of lanthanum, are due to an admixture of yttrium, this abnormal value reappeared once more in chemical literature. Schützenberger, in 1895 (*Comptes Rendus*, cxx., 1143), found that some fractions of lanthanum contained the ordinary lanthanum, La=138, others a second lanthanum with the atomic weight La=135. This lower number is regarded by Rydberg (*Zeit. Anorg. Chem.*, 1897, xiv., 99) as the real atomic weight of lanthanum, as, according to his view, it agrees better with certain numerical relations observed by him in atomic numbers.

The objects of the present work were:—

(1) To ascertain whether the purest lanthanum preparations, that is, those corresponding with the *most basic* of all cerite earths, are homogeneous, and what is the real atomic weight of the element contained in them.

(2) To determine whether the atomic weight of lanthanum is somewhat higher than 138·4, for, according to the "twin rule" of Lorenz (*Zeit. Anorg. Chem.*, 1895, xii., 329), it ought to approach the number La=139.

In this connection, it may be pointed out that if the number C=139·0, calculated from the determinations of Wyrouboff and Verneuil (*Bull. Soc. Chim.*, 1897, [3], xvii., 679), by Clarke (*Annual Report of the Committee of Atomic Weights*, 1897), for the atomic weight of cerium, be correct, we should expect the atomic weight of lanthanum to be considerably lower than La=139.

(3) To investigate once again the question whether or no, in ordinary lanthanum free from yttrium, fractions are contained the element of which possesses an atomic weight of 135.

(4) To discover whether the classical method used for the determination of the atomic weights of almost all rare earth elements, that is, the conversion of the oxide into the sulphate, contains any hidden source of error.

Preparation of Material.

In 1873 (*Annalen*, clxviii., 45), a new method was described by Mendeléeff for the easy separation of lanthanum from didymium. It consists in re-crystallising the double nitrates with ammonium nitrate from an aqueous solution.

This method was modified by Auer von Welsbach, in 1885 (*Monatsh.*, vi., 491), who did not quote Mendeléeff, and is therefore wrongly regarded as the originator of the method, by re-crystallising the double nitrates in the presence of nitric acid. At the end of his paper, in which the separation of the old didymium into "neodym" and "praseodym" (the latter separates with lanthanum) is described, this author says that lanthanum, like his "twin" didymium, will sooner or later disappear from the series of elements, a statement which means that, in his opinion, it consists of a mixture of elements.

This fact was observed by me previously, in 1882 (*Monatsh.*, iii., 176). A most "negative" fraction was obtained from lanthanum with an "atomic weight" of $R^{III}=140·19$, and in the spark spectrum, in which the yttrium lines were prominent, some lines belonging neither to lanthanum nor to yttrium were observed.

Mendeléeff's method, as modified by Auer, was employed for the purification of the lanthanum material used by Bettendorff in 1892, as well as by Gibbs and Shapleigh in 1893 in their atomic weight determinations (see Table I.). Quite recently, Melikoff and Pissarjewsky (*Zeit. Anorg. Chem.*, 1899, xxi., 70), without knowing that they return to Mendeléeff's original method, recommend re-crystallisation from the *neutral* solution for the preparation of pure lanthanum compounds.

Many years ago, fractional precipitation with magnesia was recommended for the above purpose by Stolba. Drossbach (*Ber.*, 1896, xxix., 2452) used it for the separation of the yttrium earths. Without quoting their predecessors, Muthmann and Rölig (*Ber.*, 1898, xxxi., 1718) recommend it for the *easy* and *rapid* preparation of *pure* lanthanum compounds, and they obtain from 470 grms. of the crude oxide mixture 200 grms. of *perfectly pure* lanthanum oxide. However, in a paper by Ley (*Zeit. Physikal. Chem.*, 1899, xxx., 236), we find in a footnote the surprising statement that Muthmann and Rölig's material was in reality far from being pure, and contained yttria earths. Its original atomic weight was $R^{III}=139·5$ and after fractionation a less basic portion with an atomic weight of $R^{III}=140·1$ and a more basic portion with an atomic weight La=138·4 *are said* to have been obtained.

The material which was used for the preparation of lanthanum compounds for the purpose of the present investigation was obtained from cerite. Since the year 1885, much time has been devoted by me and by some of my advanced students to the fractional crystallisation of a considerable quantity of the double ammonium nitrates of a crude mixture of lanthanum and old didymium free from cerium by the Mendeléeff-Auer method. After a long series of crystallisations, lanthanum was obtained free from praseodym, neodym, and the whole of the elements of the samarium, gadolinium, and yttrium group.

For the further purification, a *second method* was used consisting in the fractional fusion of the lanthanum nitrate thus obtained with a mixture of potassium and sodium nitrates in molecular proportion (Debray-Schützenberger method). A trace of cerium and of the less basic earths was removed first by fusing for half a day at 350°; the mass was dissolved in water, filtered, and the residue washed with a saturated solution of the alkali nitrates in water in order to avoid the finely divided oxides passing into the filtrate.

The filtrate from this fraction, A1, was carefully evaporated down and the moist residue obtained had to be dried very carefully before fusion, a tedious operation requiring a great deal of time.

On repeating the fusion, &c., first at 450—500° and for the last fractions even at a higher temperature, the fractions A2, A3, A4, A5, and A6 were obtained. They consisted of basic lanthanum nitrate and were perfectly white.

A *third method* of fractionation was used for the further purification of the highly purified lanthanum material, A6, which did not contain the slightest trace of an yttria earth or of an earth yielding an absorption spectrum. Instead of using such weak bases as ammonia or magnesia, or of following Drossbach, who used sodium hydroxide, we used the most powerful base available, namely, potassium hydroxide, which precipitates lanthanum as the hydroxide. The latter, on being digested with a hot solution of, for example, lanthanum nitrate, is converted into the basic nitrate, and in such a precipitate the *least basic* portion contained in the solution is accumulated, whereas the most basic or positive portion passes into the solution. In this way, lanthanum solutions are precipitated by lanthanum hydroxide.

The method of fractionation differed in one essential point from similar methods hitherto used, for instead of precipitating *small* fractions and leaving the greater part in solution, the *larger* part was precipitated, leaving only the *smaller* part in solution—this considered to be the fraction sought.

After calculating from a preliminary experiment the volume of a definite dilute solution of potassium hydroxide necessary for the *complete* precipitation of lanthanum, sufficient was added to the main solution to precipitate seven-eighths and to leave one-eighth in solution. The addition was made drop by drop from a large burette and the precipitate digested for some time with the solution and then filtered.

After dissolving the precipitate in the smallest amount of dilute nitric acid, and repeating the above process of fractionation, the following eight fractions were obtained:—La0, La1, La2, La3, La4, La5, La6, La7. If lanthana is a mixture of earths, the lower fractions must contain the most basic (positive) portion, whereas the least basic (negative) portion will be accumulated in the highest fraction.

The solutions containing the above fractions were first completely precipitated by potash, the washed precipitate was dissolved in an insufficient quantity of dilute nitric acid, which was added drop by drop with stirring, and the solution filtered from a small, insoluble residue consisting chiefly of silica and other negative impurities.

After this, recourse was had to repeated precipitation with ammonia and washing of the precipitate in order to remove the alkalis completely. From the nitric acid solution of the last precipitate, lanthanum oxalate was in each case precipitated by adding a dilute solution of sublimed oxalic acid drop by drop. The crystalline, white, and fine powder of the precipitate was well washed with water, but as the mode of washing has a great influence on the *composition* of the oxalate, this point will be more fully treated in a subsequent section.

Method of the Atomic Weight Determination.

It has been generally considered that the most simple and trustworthy method for the determination of the atomic weight of the element of a rare earth is the conversion of the oxide R_2O_3 into the sulphate $R_2(SO_4)_3$.

Bunsen dissolved the oxide in dilute sulphuric acid and removed the excess by evaporation, but as the reaction is an exothermic one, and the sulphates are only slightly soluble at a low, and still less so at a higher, temperature, some solid sulphate may separate out before the oxide has dissolved completely.

In order to avoid the error due to incomplete solution in sulphuric acid, the oxide is now generally dissolved in nitric acid, after which dilute sulphuric acid is added and the excess of the acids removed by evaporation.

In chemical literature, very vague and incomplete indications are found regarding the temperature at which the excess of sulphuric acid is removed from the sulphate. Although sulphuric acid boils at 338°, a much higher temperature than this is recommended for its removal, and the sulphate is generally heated for some time at, or a little above, 400° in order to remove all free sulphuric acid.

The only chemist who has directed his attention to the question of the equilibrium between the basic and acid constituents of the sulphate of a rare earth is Bailey (*Trans.*, 1887, li., 683). On heating "didymium" sulphate containing an excess of sulphuric acid slowly to and above 360° he could not find any range of temperature within which the weight of the salt would remain perfectly constant. Each increase in temperature led to a further loss of weight and an equilibrium could not be obtained. Bailey says that it remains to be seen whether the other earths of this group show similar variations.

It should be added that a means of ascertaining whether the sulphate obtained by synthesis is normal was proposed by Cleve, Nilson, and others: it must dissolve in water without leaving an insoluble residue of the basic sulphate. This test only shows whether *too much* sulphuric acid has been removed, and yet we shall see that this criterion is not trustworthy. No one, however, has considered the other side of the question: How can we find out whether the sulphate does not contain an *excess* of sulphuric acid?

In the experiments recorded in this paper, we proceeded as follows. Air-dried lanthanum oxalate was heated gradually and carefully until the oxide was obtained. This was heated in a double platinum crucible* to the highest yellow heat in a strongly oxidising flame.

* The proposal to heat the platinum crucible (with the substance) which is to be weighed inside another platinum crucible was made by my former teacher, Prof. Stolba, some thirty years ago. The inner crucible does not come into contact with the flame gases, and does not change its weight. Its surface does not become rough by crystallisation, or from little sand and dust particles which, being projected on the soft, white-hot metal, stick to it and make it often heavier. I have used the same crucibles for the last twenty years, and they look like new to-day, and, what is more important, *they do not leak*, whereas crucibles which are heated *directly over the blast* invariably do so after a few months' use, so that they become unfit for any kind of exact work.

The oxide obtained from the fractions La 0, La 1, La 2, La 3, and La 4 was at first perfectly white, but on being heated for a longer time the part in contact with the hot walls of the platinum crucible assumed an extremely slight pale buff tint. This tint was slightly more prominent in the higher fractions, especially in La 7.

Lanthanum oxide, which was weighed after cooling over phosphoric oxide, was slowly and carefully dissolved in water to which nitric acid was added very gradually, after which a small excess of dilute sulphuric acid of known strength was added. A blank experiment made with the quantities used (5—10 c.c. of water, 2 c.c. of nitric acid, and 3 c.c. of sulphuric acid) showed that the residue obtained on evaporation in the air and after heating at 500° is inappreciably small.

After evaporation to dryness, the platinum crucible was fastened in the centre of a large porcelain crucible having in its lid a thermometer graduated up to 550°, by which at least the order of the temperature was indicated. The large crucible fitted into a larger plate of asbestos cardboard in order to exclude the products of the combustion of coal-gas (chiefly water and carbon dioxide) from the atmosphere of the crucible.

Experiment I.—0·97175 grm. La_2O_3 was converted as above into the sulphate, and the latter containing an excess of sulphuric acid was heated in the crucible air-bath.

Time of heating.	Temperature.	Weight of sulphate in grms.	"Atomic Weight" of La.
3 hours	350° ±	1·7112	133·70
5 "		1·7025	133·52
5 "		1·6990	136 28
6 "		1·6982	136·48
5 " (total 24 hours)		1·6982 constant	136·48
3 "	450° ±	1·6978	136·56
6 "		1·6955	137 06
6 "		1·6949	137·20
4 " (total 19 hours)		1·6938 constant	137·45
Direct flame in hand below red heat	—	1·6935	137 41
		1·6930	137·62

It is seen from this experiment how slowly and incompletely the excess of sulphuric acid is driven off, and it will be seen later on that it cannot be driven off completely unless the substance be heated 200—300° above the boiling point of the acid.

This behaviour is undoubtedly due to the presence of an acid sulphate of lanthanum analogous to the acid sulphate of cerium described by Wyrouboff (*Bull. Soc. Chim.*, 1890, [3], ii., 275). The vapour pressure of sulphuric acid in this salt must be smaller than that of the free sulphuric acid. The partial formation of this salt was confirmed by our experiments.*

Lanthanum sulphate, obtained in Experiment I., was dissolved in water, and the solution was found to be *strongly acid* towards ethyl-orange. But first the question had to be considered whether and how far normal lanthanum sulphate is hydrolysed in aqueous solution.

Ley (*Zeit. Physikal. Chem.*, 1899, xxx., 236) found by physical methods that salts of lanthanum with strong acids are only very slightly hydrolysed at the ordinary temperature, so that, for example, lanthanum chloride in aqueous solution shows, in the presence of phenolphthalein, a very slightly acid reaction, but he says nothing about the sulphate.

* In order to avoid the mere assumption of the existence of a hypothetical acid sulphate of lanthanum, I asked Mr. Picek to prepare it. He succeeded in doing so by a novel method, differing from that used by Wyrouboff. The result of this work was the preparation of a whole series of acid sulphates in a pure state possessing the general formula $R^{III}_2(SO_4)_3,3H_2SO_4$, in which R^{III}=Ce, La, Pr, Nd, Y, and Sm. This fact was communicated to the Chemical Society on February 24, 1902. As the acid sulphates of Pr and Nd were described several weeks later by Matignon (*Compt. Rend.*, 1902, cxxxiv, 657), I am obliged to make this statement in order to prove that our discovery was made independently of that of Matignon.

Behaviour of Lanthanum Sulphate towards Ethyl-orange.

A larger portion of lanthanum oxide from the fraction A5+6 was converted into the sulphate with all due precautions, and this was heated for a long time to incipient redness in order to remove the excess of sulphuric acid as far as possible. It was dissolved in 6 parts of ice-cold water. One part of this solution was heated to 35—40°; the hydrated salt which separated out was collected on a perforated platinum plate with the aid of a pump and well washed with water. From another part of the solution, the salt was precipitated with alcohol, collected at the pump, and well washed. The salt prepared by either method was heated in the crucible air-bath for a long time at about 550°, and 1 grm. of the anhydrous substance dissolved in 50 grms. of water.

On addition of 5 drops of a dilute (1 : 500) alcoholic solution of *our* ethyl-orange, which was found to be more sensitive as regards the transition near the neutral point than *our* methyl-orange, the above *standard* solution of lanthanum sulphate was found to be very nearly neutral; it exhibited, however, a slight but distinct orange tint as compared with the same quantity of water containing the same quantity (5 drops) of ethyl-orange which was more yellow, so that it would seem that it is *very slightly* hydrolysed in aqueous solution.

In all atomic weight determinations recorded below, the lanthanum sulphate was dissolved in 50 parts of water, and after addition of 5 drops of our ethyl-orange these solutions were titrated with N/20 to N/30 solution of sodium hydroxide (sometimes a N-20 solution of sulphuric acid was also used, and the titration was done to and fro) until the above "standard" tint was reached. The volume of the alkali used was reduced to the corresponding volume of the N/10 solution and every c.c. multiplied by 0·0049038. The weight of sulphuric acid obtained is then subtracted from that of the weight of the "*crude*" sulphate.

As it was found in several preliminary experiments, not recorded here, that the synthetical lanthanum sulphate, which was heated at about 500°, was rather strongly acid, so that the correction determined acidimetrically would be rather large, we tried to diminish it by heating the salt at about 550° in an atmosphere of ammonia. For this purpose, ammonium carbonate was projected upon the red-hot bottom of the porcelain crucible containing in its centre the open platinum crucible, after which the lid of the porcelain crucible was replaced immediately. After several repetitions of this process, the sulphate obtained was far less acid, and even sometimes *neutral* or *normal*, as regards the aqueous solution finally obtained.

Lanthanum sulphate, obtained by evaporation of its nitric acid solution, forms a loose mass of fine needles. On heating the salt to a temperature which in some cases may have finally exceeded 600°, that part which adheres to the platinum walls of the crucible may become partly converted into the *basic* salt, that part which lies nearer the centre may consist of the *normal* salt, and the uppermost inner layer may consist of some incompletely decomposed *acid* sulphate. On dissolving such a mixture in water tinted with ethyl-orange, the salt at first rapidly dissolves with an acid reaction, then the solution proceeds more slowly, the acid reaction diminishes, and the last insoluble portion containing the basic salt is brought into solution slowly but completely by the free sulphuric acid resulting from the hydrolysis of the acid sulphate. It is a matter of mere chance that in some experiments the aqueous solution of the sulphate resulting after the above equilibrium had taken place was neutral. In other cases it was acid.

In none of the 27 experiments recorded in this paper was the solid lanthanum sulphate prepared by synthesis homogeneously neutral or homogeneous in all its parts. This is due to the circumstance that it hitherto has been found impossible to heat the system: crucible + sulphate, throughout exactly *to the same temperature.*

The above process may be called one of "self neutralisation." If it takes place according to an equation such as this—

$$3[La_2O_3,2SO_3]+La_2O_3,3SO_3,3H_2SO_4+Aq = 4[La_2O_3,3SO_3]+3H_2O+Aq$$

it is seen that some water is set free, but no account can be taken of its quantity in the final calculation of the atomic weight. However small this unknown factor may be, it tends to make the atomic weight lower than the true number.

It is seen from the above that the criterion proposed by Cleve and others for the test of normality of the sulphate obtained by synthesis does not hold good, for we are not entitled to reject the results of those experiments in which the sulphate does not dissolve in water at once but only after some time.

(To be continued).

ON THE DETERMINATION OF LEAD IN ORES.*

By IRVING C. BULL.

(Continued from p. 44).

G. *Dichromate Method.*

POPE'S method consisted in converting the lead to lead sulphate and then to acetate, adding an excess of potassium dichromate, destroying the excess with standard arsenic trioxide solution, and titrating the excess with standard iodine solution and starch paste as indicator. This method seemed to require at a glance too much manipulation, so was not tried.

J. H. Wainwright's method is to precipitate the chromate as usual from an acetate solution, and the end noted by a silver nitrate solution giving a red-spot test on a white porcelain plate. This was found to be so inaccurate and troublesome, even on standardising a dichromate solution with a known strength lead acetate solution, that the method was not executed; high results would be always obtained, the cause being that the end point is obscured by the yellow lead chromate which reacts with the silver nitrate; this may, however, be somewhat overcome by boiling the solution hard after each addition of potassium dichromate, and allowing to settle.

Sutton's back titration was carried out as follows:—Follow out the gravimetric lead sulphate method through the point where the lead sulphate is dissolved in ammonium acetate. Dilute this acetate solution to about 150 c.c. and boil, run in a sufficient amount of a standard solution of potassium dichromate to precipitate all the lead and about one-third as much again in excess, boil hard for two minutes, filter quickly on a Gooch crucible, and wash thoroughly with hot water until there is no yellow colour to the wash water, dilute the filtrate to 400 c.c., and titrate with standard solution of ammonium ferrous sulphate at 60° C., after acidifying the solution with about 15 c.c. of dilute hydrochloric acid or 5 c.c of concentrated sulphuric acid. The end point is noted by a dark blue colour produced when a drop of the titrated solution is added to a drop of potassium ferricyanide upon a white porcelain plate.

This excess of dichromate may also be determined by adding 3 or 4 grms. of potassium iodide to the solution, keeping it about 600 c.c. bulk and normal temperature, 15 c.c. of concentrated sulphuric acid added, and the liberated iodine titrated with a standard sodium hyposulphite solution, adding the latter until nearly to the end, then just before the end point is reached add two or three drops or

* Contribution from the Havemeyer Laboratories, Columbia University. From the *School of Mines Quarterly*, xxiii., No. 4.

c.c. of a freshly prepared solution of starch paste, and the end point noted by the disappearance of the blue colour.

The following results were obtained upon the ores, using both titrations, which agree fairly well:—

	Ferrous.			*"Hypo."*	
.. ..	78·71 per cent		1	78·71	per cent
	78·78 ,,			78·76	,,
2	37·32 ,,			78 73	,,
	37·28 ,,		2	37·33	,,
3	10·78 ,,			37·34	,,
	10·72 ,,			37·37	,,
4	18·48 ,,		3	10·80	,,
	18 44 ,,			10·76	,,
5	27·31 ,,			10·81	,,
	27·27 ,,		4	18·50	,,
6	38·46 ,,			18·45	,,
	38·52 ,,		5	27·26	,,
				27·32	,,
			6	38·57	,,
				38·60	,,
				38·56	,,

The results obtained by making weighed additions of impurities, using the ferrous titrations, were as follows:—

Bismuth.

						K dichromate sol.
1.	30 c.c.	PbA sol.	2·5 c.c.	Bi nitrate sol.		19·30 c.c.
2.	30 ,,	,,	5 ,,	,,	,,	20·09 ,,
3.	30 ,,	,,	10 ,,	,,	,,	21·60 ,,
4.	30 ,,	,,	20 ,,	,,	,,	26·44 ,,
5.	30 ,,	,,	40 ,,	,,	,,	34·20 ,,

Antimony.

1.	30 c.c.	PbA sol.	0·0 c.c.	Sb chloride sol.		18·60 c.c.
2.	30 ,,	,,	2·5 ,,	,,	,,	19·40 ,,
3.	30 ,,	,,	5 ,,	,,	,,	21·10 ,,
4.	30 ,,	,,	10 ,,	,,	,,	21·66 ,,
5.	30 ,,	,,	20 ,,	,,	,,	24·80 ,,

Barium.

1.	30 c.c.	PbA sol.	2·5 c.c.	Ba chloride sol.		19·81 c.c.
2.	30 ,,	,,	5 ,,	,,	,,	20·83 ,,
3.	30 ,,	,,	10 ,,	,,	,,	22·80 ,,
4.	30 ,,	,,	20 ,,	,,	,,	24·64 ,,
5.	30 ,,	,,	40 ,,	,,	,,	28·30 ,,

Strontium.

1.	30 c.c.	PbA sol.	2·5 c.c.	Sr chloride sol.		18·90 c.c.
2.	30 ,,	,,	5 ,,	,,	,,	19·20 ,,
3.	30 ,,	,,	10 ,,	,,	,,	19·93 ,,
4.	30 ,,	,,	20 ,,	,,	,,	21·00 ,,
5.	30 ,,	,,	40 ,,	,,	,,	21·88 ,,

Calcium.

1.	30 c.c.	PbA sol.	2·5 c.c.	Ca chloride sol.		18·70 c.c.
2.	30 ,,	,,	5 ,,	,,	,,	18·76 ,,
3.	30 ,,	,,	10 ,,	,,	,,	19·34 ,,
4.	30 ,,	,,	20 ,,	,,	,,	20·20 ,,
5.	30 ,,	,,	40 ,,	,,	,,	21·50 ,,

In the above titrations the back titration with the ferrous solution has not been recorded, but the number of c.c. of the potassium dichromate actually required is given.

H. *Ferrocyanide Method.*

This method was first described by Low in the Chemical News for 1897, but on account of the lack of proper conditions the method proved somewhat erroneous. The method here pursued was as follows:—The lead sulphate was obtained as described in the gravimetric lead sulphate method. Add 10 c.c. of a cold saturated solution of commercial ammonium carbonate, and heat gently to boiling to prevent spattering, the heating being necessary to ensure the complete conversion of any sulphate of calcium to carbonate. Cool to ordinary temperature, and filter through the original filter, washing the precipitate, and flask thoroughly with cold water until no alkaline reaction is noted. Place in the flask about 5 c.c. of glacial acetic acid and 25 c.c. of distilled water and heat, place in this solution when hot the filter and precipitate of lead carbonate. Boil this until the lead carbonate is completely dissolved, dilute to about 150 c.c., heat to about 60° C., and titrate with a standard solution of potassium ferrocyanide, the end point being noted by the usual brown colour when a drop of the solution is placed on a white porcelain plate with a drop of saturated neutral solution of uranium acetate.

Beebe also describes a method similar in principle to the above in the Chemical News for 1896.

Free ammonia must be absent in the above described method, as it reacts with the uranium, interfering with the true colour, and so giving very low results. This colouration due to ammonia does not appear at once, but comes quickly as more ferrocyanide is added. Other indicators were tried, as platinic chloride; this was not affected by the salts in solution, but did not give a very sharp end reaction, so is not recommended; nitrate of cobalt was even less satisfactory.

The conditions best adapted for the titration, found by many experiments, were:—Bulk of solution to be titrated should be as near as possible to 100 c.c. containing about 10 c.c. of 50 per cent acetic acid, temperature about 60° C.; the correction for the indicator is then about eight-tenths of 1 c.c. These are the most convenient conditions to maintain and which will give the lowest allowance for the indicator. A 1 per cent potassium ferrocyanide was used. It cannot be over-emphasised that it is very important to always maintain these conditions, as a slight variation gives erroneous results on account of the variation in the composition of the precipitate.

The effect of impurities upon the method was as follows, being carried out in the usual way as before described:—

Antimony.

						K ferrocyanide sol.
1.	30 c.c.	PbA sol.	0·0 c.c.	Sb chloride sol.		35·40 c.c.
2.	30 ,,	,,	2·5 ,,	,,	,,	35·35 ,,
3.	30 ,,	,,	5 ,,	,,	,,	35·40 ,,
4.	30 ,,	,,	10 ,,	,,	,,	35·38 ,,
5.	30 ,,	,,	20 ,,	,,	,,	35·40 ,,

Bismuth.

1.	30 c.c.	PbA sol.	2·5 c.c.	Bi nitrate sol.		35·40 c.c.
2.	30 ,,	,,	5 ,,	,,	,,	35·30 ,,
3.	30 ,,	,,	10 ,,	,,	,,	35·10 ,,
4.	30 ,,	,,	20 ,,	,,	,,	35·00 ,,
5.	30 ,,	,,	40 ,,	,,	,,	34·80 ,,

Barium.

1.	30 c.c.	PbA sol.	2·5 c.c.	Ba chloride sol.		35·30 c.c.
2.	30 ,,	,,	5 ,,	,,	,,	35·20 ,,
3.	30 ,,	,,	10 ,,	,,	,,	34·98 ,,
4.	30 ,,	,,	20 ,,	,,	,,	34·85 ,,
5.	30 ,,	,,	40 ,,	,,	,,	33·80 ,,

Calcium.

1.	30 c.c.	PbA sol.	2·5 c.c.	Ca chloride sol.		35·40 c.c.
2.	30 ,,	,,	5 ,,	,,	,,	35·40 ,,
3.	30 ,,	,,	10 ,,	,,	,,	35·35 ,,
4.	30 ,,	,,	20 ,,	,,	,,	35·40 ,,
5.	30 ,,	,,	40 ,,	,,	,,	35·38 ,,

Strontium.

1.	30 c.c.	PbA sol.	2·5 c.c.	Sr chloride sol.		35·40 c.c.
2.	30 ,,	,,	5 ,,	,,	,,	35·40 ,,
3.	30 ,,	,,	10 ,,	,,	,,	35·42 ,,
4.	30 ,,	,,	20 ,,	,,	,,	35·38 ,,
5.	30 ,,	,,	40 ,,	,,	,,	35·40 ,,

The following results were obtained on analysis of the six ores.

1.	78·67	per cent
	78·65	,,
2.	37·31	,,
	37·29	,,
3.	10·90	,,
	10·86	,,
4.	18·44	,,
	18·48	,,
5.	27·25	,,
	27·18	,,
6.	38·65	,,
	38·58	,,

(To be continued).

ESTIMATION OF GLYCERIN BY MEANS OF IODIC ACID IN THE PRESENCE OF SULPHURIC ACID.

By A. CHAUMEIL.

The methods now in use for the estimation of glycerin are fairly numerous, and we have no intention of recapitulating them here. Some are so difficult of execution that they have been abandoned, while others have been dropped owing to their want of accuracy.

All the methods, however, can be divided into two groups:—

1. The ponderable methods, for the estimation of glycerin in fermenting liquors of saccharine origin (wine, beer, cider).

2. The volumetric methods, applicable to glycerins of industrial origin (soap and stearin works).

M. G. Demoussy who has studied the question carefully says ("Dictionaire de Würtz," Suppl., vol. iv., Art. "Glycerin"):—"The only method which, up to the present, appears satisfactory all round is the bichromate of potassium method, and we are of the opinion that all estimations of glycerin, without exception, should be made by means of bichromate; that is, until a more simple and more exact method has been discovered."

The method just referred to offers certain difficulties which we have endeavoured to obviate by substituting for the bichromate of potassium a much more energetic oxidising agent, viz., *iodic acid*, which has the great advantage over bichromate of potassium of not being decomposed by sulphuric acid, no matter how concentrated the latter may be.

The action of iodic acid on organic matters has been made clear by the researches of M. H. Causse; according to the nature of the substance, or rather its constitution, it is sometimes attacked directly, as in the case of uric acid or morphine; or its attack necessitates the intervention of sulphuric acid in variable quantities. All these facts have been the subject of several papers by MM. Gallimard, Bouillet, and Romeyer.

Following the advice of M. Causse I undertook a series of experiments which have led to the method I am about to describe.

Principle of the Method.

When iodic acid is placed in contact with glycerin, the latter is decomposed, carbonic acid is formed, and iodine is set free; however, under these conditions the attack is decidedly incomplete, but if we add sulphuric acid, the combustion of the glycerin is integral, and may be represented then by the following equation:—

$$5C_3H_8O_3+7I_2O_5=15CO_2+20H_2O+7I_2,$$

from which it follows that 5 molecules of glycerin, or 460 of the polyalcohol, liberate 7 molecules of iodine or 1778 of the metalloid.

Thus one part of iodine corresponds to 0·2587 grm. of glycerin; let V be the volume of decinormal hyposulphite of soda used to estimate the iodine set free, and of which 1 c.c. corresponds to 0·0127 grm. of iodine; the glycerin $=V\times0{\cdot}0127\times0{\cdot}2587$.

Before going into details of the operation we will take two typical cases like M. Demoussy, viz., the glycerin contains substances like chloride of sodium capable of acting on iodic acid, or it does not.

First Case:—The Glycerin is Free from Substances Acting on Iodic Acid.

The solutions necessary for making an estimation are:—A solution of iodic acid at one-fifth, and a decinormal solution of hyposulphite of sodium.

The apparatus we used is the same as that used by Mohr for the estimation of iodine.

Details of the Operation.

Into a tared crucible we pour a certain quantity, about 10 grms. of glycerin, and find its weight; dissolve in distilled water, and make the volume up to a litre. Place 10 c.c. of this solution in the flask, and add successively 25 c.c. of the iodic acid solution, 50 c.c. of sulphuric acid, and a fragment of marble. The flask is closed by means of the bulb-tube, and the condensing apparatus is plunged into a refrigerating vessel and furnished with iodide of potassium at one-fifth; the distillation is commenced, the iodine is given off, and dissolves in the iodide; at the same time the liquor in the flask becomes decolorised, though it still retains a pale yellow tint. This is due to the presence of a large quantity of sulphuric acid; it is probable that sulphuric ethers are formed from the glycerin which resists the attack of the iodic acid. Allow to cool for an instant, and add 25 c.c. of water; the liquid is again coloured, and a second distillation is made after having renewed the iodide in the condenser. When the contents of the flask are completely decolorised it is allowed to cool again, and we make sure that the combustion of the glycerin is complete by adding another 25 c.c. of water. Generally we obtain a slight colouration which corresponds to a few m.grms. of iodine, and which must be driven off into the iodide by distillation. There only remains now to add together the condensed liquids and titrate with decinormal hyposulphite.

Remarks.

Experience has shown us that three additions of water, under the given conditions, are necessary and sufficient to effect the combustion of the glycerin. Its *rôle* is easy to understand; it saponifies the sulphuric ethers of the glycerin, and the latter is set free and then oxidised by the iodic acid. The use of marble facilitates the operation in a remarkable manner; the carbonic acid which is given off maintains a slight pressure in the apparatus, and prevents the absorptions which are often so fatal in this class of estimation, especially at the end of the operation; but in such a case it is necessary to use a much longer condenser tube to make certain of the condensation of the iodine.

Wt. of glycerin in 10 c.c. of solution. Grm.	Volume of N/10 hyposulphite used. C c.	Glycerin by the iodic acid method.	Glycerin by the bichromate method.	Results, per cent. Iodic acid method.	Bichromate method.
10 c.c. = 0·0916	27·4	0·09001	0·08793	98·27	94·9
10 c.c. = 0·1154	34·8	0·115316	0·12398	99·90	107·1
10 c.c. = 0·08097 (commercial glycerin) ..	23·0	0·075566	0·06395	93·32	79·0

In the above table we give the results obtained both with the bichromate method and by the method we have just described; the operations were carried out on the same solution.

Second Case:—The Glycerin contains Chlorides.

We have mentioned above that for this particular case M. Demoussy recommends the elimination of the chlorides by a preliminary treatment with carbonate of silver.

Table Summing-up the Results of the Different Estimations of Glycerins by Iodic Acid.

Weight of glycerin at 30° B. in the sample.	Volume of N/10 solution of hyposulphite used.	Glycerin found.	Results per cent of material.
			Per cent.
Glycerin free from Chlorides.			
10 c.c. = 0·10 grm. glycerin	28·5 c.c.	0·09363	93·63
10 c.c. = 0·15886 „ „	47·3 „	0·15608	97·18
10 c.c. = 0·15886 „ „	47·5 „	0·15673	97·06
10 c.c. = 0·09926 „ „	29·4 „	0·96593	97·30
10 c.c. = 0·1154 „ „	35·1 „	0·11532	99·90

Glycerins containing Chlorides.

	Grm.		C.c.		
10 c.c. contained—Glycerin ..	0·0915	Volume of hypo. (total) ..	28·5		
KCl	0·00585	Volume nitrate of silver ..	0·8		
		Actual volume of glycerin ..	27·7	0·91005	98·47
10 c.c. contained—Glycerin ..	0·0877	Volume of hypo. (total) ..	27·9		
NaCl	0·0108	Volume nitrate of silver ..	1·8		
		Actual volume of glycerin ..	26·1	0·08574	97·90
Recovered Glycerin—					
10 c.c. contained—Glycerin ..	0·1766	Volume of hypo. (total) ..	27·3		
NaCl	(found)	Volume nitrate of silver ..	3·7		
		Actual volume of glycerin ..	23·6	0·07753	43·91

The method we have adopted is more simple, and consists of titrating the glycerin directly, and subtracting from the volume of the hyposulphite used that accounted for by the chlorides. The principle of the estimation is therefore as follows:—

1. In a known volume of the solution of impure glycerin we estimate the chlorine by the volumetric method, and obtain thus a volume V of hyposulphite.

2. If we submit the mixture of glycerin and chloride to the action of iodic acid, not only is the glycerin burnt under the circumstances described above, but the chloride also is decomposed with the liberation of iodine according to the equation:—

$$I_2O_5 + 10HCl + 10KI = 10KCl + 5H_2O + 6I_2,$$

according to which 10 molecules of hydrochloric acid correspond to 12 atoms of iodine, or again 355 of chlorine to 1524 of iodine.

Now, 1 c.c. of decinormal iodine is equivalent to 0·0127 grm. of iodine.

Therefore, if x represents the volume of this solution containing 0·01524 grm. of iodine, we find that this volume is given by the equation:—

$$x = \frac{1 \times 0{\cdot}01524}{0{\cdot}0127} = 1{\cdot}2 \text{ c.c. of N/10 iodine.}$$

This gives the following proposition:—If V is the total volume of decinormal hyposulphite, and if v represents the volume of decinormal silver solution, used to estimate the chloride, to transform this latter into the actual value of hyposulphite it suffices to multiply v by the factor 1·2. By subtracting this product ($v \times 1{\cdot}2$) from V, the difference $V - (v \times 1{\cdot}2)$ will give the iodine corresponding to the glycerin only.

Example:—Let V = 28·6 c.c., the amount of decinormal hyposulphite found, and v = 0·8 c.c. the amount of decinormal nitrate of silver; then we have 28·6 c.c. $-(0{\cdot}8 \times 1{\cdot}2)$ = 27·64 c.c., and the weight of the glycerin will be found by the equation, $W = 27{\cdot}64 \times 0{\cdot}0127 \times 0{\cdot}2587$.

Details of the Operation.

We prepare a solution of impure glycerin of about 1 per cent strength.

1. On 50 c.c. of this solution we estimate the chlorides directly with decinormal silver solution, using neutral chromate of potassium as indicator and carbonate of lime to neutralise the acidity if it exists; the volume found thus is calculated for 10 c.c.; call this v.

2. Take 10 c.c. of the solution of glycerin and place it in the flask, add successively sulphuric acid, iodic acid, and a fragment of marble, and proceed with the distillation under the same conditions as already described; titrate with hyposulphite; let V be the volume obtained, we subtract the volume v, transformed, as has been said, into iodine, and the difference multiplied successively by the corresponding factors is transformed into glycerin; finally, the result is calculated per 100.

Recovered Glycerin.

Certain industries, such as soap making and the manufacture of some pharmaceutical products (glycerophosphate of lime), leave glycerins charged with chloride of sodium and sometimes other salts. These glycerins are concentrated, the salt which separates is removed, and the recovered glycerins used again in manufacture. Their analysis is effected in the same manner as we have described; only, in the case of the glycerophosphates, the solution contains phosphoric acid; the chlorine is estimated by Wohlard's method, and the operation is carried out as above.

We propose applying this method of estimation to the determination of the glycerin in certain liquors of fermentation, and also to some pharmaceutical preparations. —*Bull. Soc. Chim.*, Series 3, vol. xxvii., No. 12.

ON THE ACTION OF CARBONIC OXIDE ON FERROCYANIDE OF POTASSIUM IN SOLUTION.

By J. A. MULLER.

It is a known fact that carbonic oxide acting on ferrocyanide of potassium in solution gives carbonyl-ferrocyanide of potassium, and that the transformation of the ferrocyanide into the carbonyl-ferrocyanide may become total, or practically so, in the presence of a sufficient excess of carbonic oxide.

Now, carbonic oxide also gives carbonyl-ferrocyanide of potassium when acting on dissolved ferricyanide of potassium, and the transformation is not preceded by a preliminary formation of ferrocyanide, as we should be inclined to believe *a priori*, but it is formed directly, as will be seen later on.

I have made a number of experiments by heating solutions of ferricyanide of potassium in an atmosphere of carbonic oxide in sealed tubes at about 130°. When the carbonic oxide is in sufficient excess I have always obtained carbonyl-ferrocyanide as the principal product of the reaction, and, in much less quantity, ferrocyanide of potassium; further, there was a production of formate and bicarbonate of ammonia as well as free carbonic

anhydride. Finally, the liquid in the tubes held in suspension a very slight greenish precipitate containing iron, and also a little potassium. This precipitate is soluble in fuming hydrochloric acid, giving a yellow colouration; when treated with water the solution changes from yellow to prussian-blue. I have taken for the composition of this precipitate—of which the weight never exceeded a few hundredths of the ferricyanide used—the formula $KFe_2\overline{CN}_6$, which represents ferrocyanide of potassium in which 3 atoms of this metal would be replaced by 1 atom of ferric iron. The amount of the precipitate in question was proportionally less as the transformation of the ferricyanide into carbonyl-ferrocyanide was more complete.

From an examination of the estimations made, the action of carbonic oxide on ferricyanide of potassium in solution may be expressed by the two simultaneous and independent reactions which follow, when the gas is in excess:—

a. $6K_3Fe\overline{CN}_6+7CO+15H_2O=$

$=6K_3FeCO\overline{CN}_5+4HCO_2NH_4+2HCO_3NH_4+CO_2.$

b. $7K_3\overline{CN}_6+3CO+15H_2O=$

$=5K_4Fe\overline{CN}_6+KFe_2\overline{CN}_6+6HCO_2NH_4+3CO_2.$

The two following experiments—in which nearly all the compounds formed were estimated, and in which the weights of these compounds were calculated according to the two preceding reactions—show an agreement between the numbers thus calculated and those given by analysis.

These experiments were carried out by heating for eighty hours, at 130—135°, aqueous solutions containing respectively 0·510 grm. of ferricyanide in 5 c.c. and 1·039 grm. of the same salt in 10 c.c. in the presence of an excess of carbonic oxide.

In the following table all the gaseous volumes are reduced to 0° and 760 m.m. in the dry state:—

	Expt. A.	Expt. B.
$K_3Fe\overline{CN}_6$ used..	0·510 grm.	1·039 grm.
CO used	77·1 c.c.	79·4 c.c.
CO absorbed—Found	30·6 ,,	47·4 ,,
Calculated ..	31·4 ,,	55·0 ,,
CO_2 formed—Found	6·7 ,,	14·9 ,,
Calculated ..	6·2 ,,	16·0 ,,
$K_3FeCO\overline{CN}_5$ formed (*a*) ..	0·467 grm.	0·818 grm.
$K_4Fe\overline{CN}_6$ formed (*b*)	0·025 ,,	0·189 ,,
a+*b* corres. to $K_3Fe\overline{CN}_6$ ..	0·496 ,,	1·050 ,,
HCO_2NH_4 formed—Found ..	—	0·125 ,,
Calculated	—	0·136 ,,
HCO_3NH_4 formed—Found ..	0·039 ,,	0·061 ,,
Calculated	0·037 ,,	0·065 ,,

It results from the figures in the above table that the centesimal compositions of the ferrocyanides formed under these conditions are as follows:—

	A.	B.
$K_3FeCO\overline{CN}_5$	94·9	81·2
$K_4Fe\overline{CN}_6$	5·1	18·8
	100·0	100·0

As can be seen, in the presence of a large excess of carbonic oxide, the reaction *a* takes place almost exclusively, and the reaction *b*, that is to say, the one that gives rise to the formation of ferrocyanide, has an entirely secondary importance.

This experiment shows plainly that the transformation of the ferricyanide into carbonyl-ferrocyanide is direct; for if ferrocyanide was formed first according to reaction *b*, and the carbonyl-ferrocyanide according to the well-known reaction—

$K_4Fe\overline{CN}_6+CO+2H_2O=K_3FeCO\overline{CN}_5+HCO_2K+NH,$

the amount of CO_2 formed would be much greater than that observed. Further, 7 molecules of ferricyanide would only thus furnish 5 molecules of carbonyl-ferrocyanide, while in experiment A 1 molecule of ferricyanide was transformed almost integrally into 1 molecule of carbonyl ferrocyanide.

Finally, in this latter experiment the greenish precipitate, to which I gave provisionally the composition $KF_2\overline{CN}_6$, was entirely negligible, so that if the ferricyanide had commenced by forming ferrocyanide according to equation *b*, this precipitate should have been, on the contrary, very considerable.*

In my experiments on the action of carbonic oxide on ferrocyanide of potassium, I have found that no reaction takes place in the absence of water (*Bull. Soc. Chim.*, vol. xxi., p. 475); the same is the case with ferricyanide of potassium, whice does not react with carbonic oxide in the dry state.—*Bull. Soc. Chim.*, Series 3, vol. xxix., p. 24.

RICKARDITE: A NEW MINERAL.

By W. E. FORD.

The new mineral to be described in this paper was first brought to the writer's attention by Mr. T. A. Rickard, of New York. A qualitative examination proved that in contained copper and tellurium, and no such combination having been hitherto described, the mineral seemed worthy of investigation. Through the courtesy of Mr. Rickard, sufficient material was afterward obtained for making a quantitative analysis, the results of which are given below.

Rickardite occurs at Vulcan, Col., in the Good Hope mine, owned by Dr. Loui Weiss. The vein mineral is chiefly pyrite, with which occurs native tellurium in unusually large masses, some of which measure fully three inches across. Other associated minerals are petzite, berthierite in imbedded prisms resembling stibnite, and a greenish-brown micaceous substance, perhaps roscoelite. A large body of native sulphur also was found in the vein. Rickardite itself occurs in small lense-shaped masses, generally rather intimately associated with native tellurium.

The material for analysis was broken up and carefully gone over by hand to free it from any adhering gangue, and only perfectly clean and homogeneous fragments were used. The method of analysis was simple. The powdered mineral was oxidised by nitric acid, which was subsequently removed by evaporation with sulphuric acid. To the strong sulphuric acid solution a liberal amount of hydrochloric acid was added, and then sulphur dioxide gas was led into the solution, which precipitated the tellurium in metallic form. This precipitate was filtered on to a Gooch crucible, dried in the air-bath at 100° C., and then weighed. In the filtrate copper was precipitated by hydrogen sulphide and determined as cuprous sulphide by igniting in a stream of hydrogen. Careful tests were made for gold, silver, lead, selenium, sulphur, arsenic, and antimony, with only negative results.

The analysis follows:—

	I.	II.	Average.	Atomic ratios.
Cu =	40·68	40·81	40·74	0·6469 = 4·00
Te =	59·36	59·06	59·21	0·4737 = 2·93
Total	100·04	99.87	99·95	

These results give the ratio Cu : Te = 4·00 : 2·93, or very nearly 4·00 : 3·00, and the formula for Rickardite therefore is Cu_4Te_3. This gives as the theoretical composition of the mineral, Cu = 40·51; Te = 59·49, which agrees very closely with the analytical determinations. Rickardite is therefore not only a new mineral but also a new type of

* It should be remarked that the theoretically possible attack of the precipitate $K\overline{Fe_2CN_6}$ by CO would give ferric carbonyl-ferrocyanide, $Fe_2CO\overline{CN}_5$, in the form of a violet precipitate; this has never been observed.

telluride, for no such four to three relation between metal and tellurium has hitherto been noted in the group of tellurides. The mineral may be regarded as consisting of one molecule of cuprous telluride and two of cupric telluride, $Cu_2Te.2CuTe$.

Rickardite has an unusual and beautiful purple colour, which rivals in intensity the deepest purple tarnish ever seen on chalcopyrite or bornite. The colour, however, in the case of Rickardite is not due to any tarnish, for it shows on a fresh fracture, and the powder of the mineral, even when ground very fine, is of the same deep colour. The mineral is massive in character, with an irregular fracture. Its hardness is 3·5 and its specific gravity was determined as 7·54. It is fusible at 1 and gives a pale azure blue flame colour tinged in the outer parts with green. Alone on charcoal before the blowpipe it gives a white coating of TeO_2 and fuses to a brittle globule of copper telluride. Fused with sodium carbonate and borax on charcoal it gives a coating of TeO_2 and a brittle globule of telluride, yielding only with considerable difficulty a malleable globule of copper. Roasted in the open tube the mineral fuses to a semi-transparent mass of brown colour, which is apparently some combination of the oxides of tellurium and copper, and only a faint sublimate of TeO_2 is formed on the walls of the tube. Heated in the closed tube it fuses and undergoes no further change. Heated in concentrated sulphuric acid it gives the characteristic reddish-violet colour of tellurium. When dissolved in nitric acid, the solution neutralised with ammonium hydroxide gives the deep blue colour of copper.

It is a pleasure to name the mineral Rickardite, after Mr. T. A. Rickard, the editor of the *Engineering and Mining Journal* of New York, who obtained the material for investigation and supplied the data as to its occurrence. Thanks are also due Dr. Weiss, of the Good Hope mine, who has been careful to secure all specimens which might be of scientific interest. In conclusion, the writer wishes to express his indebtedness to Prof. S. L. Penfield for his constant advice and assistance during the preparation of this article.—*American Journal of Science*, [4], xv., No. 85.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month Ending December 31st, 1902.

By SIR WILLIAM CROOKES, F.R.S.,
and
PROFESSOR DEWAR, F.R.S.

To Charles Perrin, Esq., M.Inst.C.E.,
Water Examiner, Metropolis Water Act, 1871.

London, January 10th, 1903.

Sir,—We submit herewith, at the request of the Directors, the results of our analyses of the 204 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, taken daily, from December 1st to December 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in previous reports.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 204 samples examined by us during the month, all were found to be clear, bright, and well filtered.

The shortage of rain still continues, the actual rainfall measured at Oxford during the month is 1·33 inches, the average fall is 2·16 inches; this leaves a deficit of 0·83 inch, and when added to the previous one of 7·9 inches, makes a total deficit for the year of 8·73 inches, or 34·5 per cent on the thirty-five years' average. There has not been an excess of rain in the Thames valley since June, 1900, though in July, 1901, the deficit was reduced to 0·9 per cent; during 1902 the deficit has never been below 30·5 per cent. It will be observed in Table A that there has been a deficit of rain in every month throughout the year; this is the first time such a thing has been recorded since we began our monthly records of the rainfall in January, 1893, exactly ten years ago.

Table A.—*Rainfall in Inches at Oxford, Month by Month, during the Year* 1902.

	Actual fall.	Mean of 35 years.	Difference from the mean.	
	Inches.	Inches.	Inches.	
January ..	0·66	2·08	−1·42	—
February ..	0·95	1·80	−0·85	—
March ..	1·20	1·47	−0·27	—
April	1·21	1·61	−0·40	—
May	1·53	1·75	−0·22	—
June	1·96	2·10	−0·14	—
July	0·62	2·49	−1·87	—
August ..	2·20	2·38	−0·18	—
September .	1·11	2·39	−1·28	—
October ..	1·55	2·76	−1·21	—
November..	2·24	2·30	−0·06	—
December..	1·33	2·16	−0·83	—
	16·56	25·29	−8·73	—

Our bacteriological examinations of 359 samples have given the results recorded in the following table; besides these we have examined 248 other samples, from special wells, standpipes, &c., making a total of 607 samples in all:—

	Microbes per c.c.
New River, unfiltered (mean of 25 samples) ..	377
New River, filtered (mean of 70 samples) ..	25
Thames, unfiltered (mean of 25 samples) ..	5885
Thames-derived water, from the clear-water wells of eight Thames-derived supplies (mean of 190 samples)..	39
Ditto ditto .. .. highest	358
Ditto ditto .. .. lowest	0
River Lea, unfiltered (mean of 25 samples) ..	326
River Lea, from the East London Company's clear-water wells (mean of 24 samples) ..	50

Of the 284 daily samples taken from the filter-wells of the Metropolitan Water Companies, and examined bacteriologically by us, five samples, or 1·7 per cent, were sterile; twenty-three samples, or 8·1 per cent, contained more than 100 microbes per c.c.; and fourteen of these samples contained more than 150 microbes per c.c. The mean number of microbes in the twenty-three samples containing more than 100 microbes (which we regard as a good standard of purity) was 177, against a corresponding mean of 165 in twenty-seven samples during November. The water supply in December, on the whole, has maintained an equal microbic purity to that of November. This exceptional condition of the supply for the winter months is no doubt due to the absence of floods in the Thames Valley, and to the unusually mild character of the season. If the large deficit in the rainfall is made up, no doubt there will be in the near future a period when the filtration of the London waters will require more than usual care. As the general filter-beds are, however, in good working order, we believe these difficulties, should they arise, will be overcome satisfactorily.

TABLE B.—*Table showing Average Monthly Bacterial Variations during the Year* 1902.

Month.	Thames, unfiltered.	Thames-derived Companies, filtered.	New River, unfiltered.	New River, filtered.	River Lea, unfiltered.	River Lea (East London), filtered.	
January	4396	30	231	15	233	7	
February	3329	27	197	9	233	8	
March	2013	28	336	13	710	12	
April	10652	31	282	9	545	26	
May	2896	31	193	12	371	37	
June	4338	32	312	16	464	35	
	4604	29	258	12	426	21	Mean of 1st 6 months.
July	2172	14	292	7	250	44	
August	5134	21	304	13	233	33	
September	2491	28	166	14	205	20	
October	8243	20	314	11	243	17	
November	2262	35	277	16	253	13	
December	5885	39	377	25	326	50	
	4364	26	288	14	251	29	Mean of 2nd 6 months.
	4484	27	273	13	338	25	Mean of 12 months.

TABLE C.—*Average Number of Microbes in the Filtered London Waters for the Past Six Years.*

	Thames-derived Companies.	New River.	River Lea.
1897	46	32	62
1898	34	30	25
1899	27	15	20
1900	21	9	10
1901	24	10	22
1902	27	13	25

TABLE D.—1902.—*Averages of the Supplies derived from the River Thames.*

	Common salt per gallon. Means.	Nitric acid per gallon. Means.	Hardness. Degrees. Means.	Oxygen required per gallon. Means.	Organic carbon per gallon. Means.	Organic carbon per gallon. Maxima.	Colour. Brown : Blue. Means.
January	2·448	1·134	15·59	0·059	0·152	0·197	21·0 : 20
February	2·299	1·078	16·47	0·041	0·119	0·160	12·7 : 20
March	2·368	0·903	15·71	0·058	0·151	0·208	17·4 : 20
April	2·345	0·840	14·97	0·047	0·136	0·164	14·9 : 20
May	2·248	0·700	13·94	0·042	0·118	0·150	13·2 : 20
June	2·266	0·727	13 61	0·051	0·128	0·142	13·8 : 20
July	2·339	0·611	13·52	0·055	0·131	0·213	17·1 : 20
August	2·171	0·652	12·78	0·041	0·098	0·132	11·1 : 20
September	2·347	0·760	12·77	0·039	0·099	0·129	13·8 : 20
October	2·347	1·009	13·45	0·038	0·093	0·116	11·3 : 20
November	2·334	0·873	14·13	0·039	0·105	0·129	12·3 : 20
December	2·329	0·971	14·44	0·059	0·166	0·224	22·6 : 20

The standard of general organic purity during the past year, as defined by chemical methods, has been maintained. As regards the month of December, the Thames-derived Companies show decided differences among themselves, which, as the supply comes from the same source, are essentially connected with differences in storage capacity and variations in the structure of the filter-beds, although the latter is of less importance in removing soluble organic matter.

The longer our experience of the bacteriological method, as applied to the analysis of the filtered supply, and the wider its application, the more we are convinced of its primary importance as a safeguard to the public. It enables us to define in a much more delicate way than is possible by chemical analysis what is an efficiently filtered water, and thereby enables the chemist to warn the engineer the moment any one of his filters shows signs of defective working. Whether the supply as regards the organic matter in solution varies more or less according to the season of the year, is of relatively small moment as compared with the knowledge that the microbic impurity is reduced to a minimum.

During the past year we have examined 6953 samples of London waters bacteriologically, as compared with 6893, 6731, and 4792 respectively in the three previous years. We have also made 2570 chemical analyses of London waters throughout this period, making a total of 9523 samples examined during the year.

The results of the filtration of the London waters are given in Tables B, C, and D.

Table B shows that during the first six months the Thames-derived Companies' clear-water wells contained on an average 29 bacteria per c.c., while the New River and River Lea supplies contained respectively 12 and 21. During the second six months, the number of bacteria in the waters from the three sources were respectively 26, 14, and 29.

We are, Sir,
Your obedient Servants,
WILLIAM CROOKES.
JAMES DEWAR.

Cellular Structure of Amorphous Bodies.—G. Cartaud.—The free surface of certain fusible metals when rapidly solidified presents the aspect of microscopic cellular tissue. An unexpected phenomenon noticed on the surface of zinc amongst other metals is the constant presence in each cell of a circular centre in relief. The author investigates the surfaces of both crystalline and non-crystalline bodies, such as collodion, aluminium, glass, &c.—*Comptes Rendus*, cxxxvi., No. 1.

NOTICES OF BOOKS.

The New Volumes of the Encyclopædia Britannica. The Ninth of the New Volumes, being Vol. XXXIII. of the Complete Work. London: *The Times*. Edinburgh: Adam and Charles Black. 1902. Pp. 945.

This volume commences with STR (Strachey, Sir John) and completes the alphabet with ZWO (Zwolle).

The article on "The Sun," by Prof. Simon Newcomb, Ph.D., &c., will be read with interest not only by physicists but by the general reader. The writer gives in a few pages a concise summary of the accepted constitution of the sun as revealed by modern astronomical observations and by spectrum analysis, together with a few remarks on sun-spots, prominences, the corona, &c.

The subject of "Telegraphy" is divided into four headings, viz., theory, land telegraphy, submarine telegraphy, and wireless telegraphy. At the present time wireless telegraphy is attracting universal attention, chiefly owing to Marconi's remarkable achievement in signalling across the Atlantic by this means. The idea of sending electrical signals without the aid of a metallic circuit or wire is by no means new. In 1842 Morse showed that it was possible to interrupt the metallic circuit in two places and yet retain power of electric communication; his plan was to place four metallic plates opposite each other in pairs, at a wide distance apart in a canal, a battery and key being in circuit on one side and a galvanometer on the other; it was found to be easy to send signals by this method. It was the discovery by Hertz in 1887 that the discharge of a condenser produced an electric wave that brought about the possibility of wireless telegraphy as we now know it. Since then there have been several distinguished men at work on the subject, among the best known being Sir Oliver Lodge; he was followed by Marconi, who has worked indefatigably to bring wireless telegraphy to a practical success.

The "Telescope" is dealt with by Prof. S. Newcomb, and the "Telephone" by Prof. C. R. Cross.

"Thermochemistry," by Prof. James Walker, and "Thermodynamics," by Prof. H. L. Callendar, are both important subjects, and are treated at considerable length. From the standpoint of the conservation of energy the relation between chemical and thermochemical action bears the following aspect:—"A given amount of any substance under given conditions possesses a perfectly definite amount of intrinsic energy, and no matter what chemical and physical transformations the substance may undergo, it will, when it returns to its original state, possess the original amount of intrinsic energy." Since the intrinsic energies of different systems are invariable, the difference is constant, so that the heat evolved when one is changed into another is equal to the heat absorbed when it is converted back again.

Amongst metallurgical subjects "Tin" is briefly mentioned in a short article by Prof. H. Louis, and "Zinc" by Mr. F. L. Clerc.

There is an appreciative biographical notice of the late Prof. Tyndall, by Sir Oliver Lodge. In the limited space available it is not possible to enter very fully into the life and work of this distinguished chemist. His life has been roughly divided into four periods:—(1) The youthful period, dominated by study in Germany and work in magnetism; (2) the slatey cleavage and Swiss glacier period; (3) the Royal Institution, and radiant heat period; and (4) the final period, including his work on light houses, dust and disease, and "amateur theology." One important practical result of Tyndall's demolition of the "spontaneous generation" fallacy is the method of intermittent sterilisation at a moderate heat, sufficient to kill the developed micro-organisms, instead of by one fierce heating, attempting to attack the more refractory undeveloped spores of the same.

"Water Supply," by Mr. G. F. Deacon, forms an interesting article which should not be overlooked. He deals with the subject in a thorough manner, starting with collecting grounds, rainfall, evaporation and absorption, &c., all of which have to be carefully considered by the water engineer. Several pages are devoted to dams, and two excellent photogravures are given, showing the dam at Lake Vyrnwy, which supplies Liverpool with water. The first picture was taken in June, 1888, and shows the valley as it was; the second picture, taken in December, 1889, from the same position, shows the valley full of water. Continuing, we find a section on the purification of water, in which the construction and action of sand-filters in removing microbes is described; sedimentation is a great help to filtration, and with the two combined there should be no difficulty in reducing the number of bacteria in waters by 99 or 99·5 per cent.

Among other articles of scientific as well as general interest we may mention "Electric Welding" by Prof. Elihu Thomson; "Surgery," by Edmund Owen, F.R.C.S.; "Technical Education," by Sir Philip Magnus, &c.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 1, January 5, 1903.

Composition of the Gases issuing from Mont Pelée. Orgin of Volcanic Phenomena.—Armand Gautier.—An analysis of the gases issuing from Mont Pelée shows that they are identical with the gases obtained by heating crystalline rocks of primitive earths to a high temperature in a vacuum. From this fact and the actual gases found the author attempts to explain in a scientific manner the origin of volcanoes.

Proportion of Hydrogen in the Atmosphere.—Armand Gautier.—The author once more investigates M. Leduc's objections to his conclusions as to the proportion of hydrogen in the atmosphere.

Activity of certain Salts of the Rare Earths as Oxidisers.—André Job.—The spontaneous oxidation of potassium-cerium carbonate, and the oxidations resulting from contact with it, is so marked that the author further examines this type of phenomena. Other salts of cerium exhibit the same reactions, and it is found that for atomic equivalent quantities cerium acetate has an activity at least as great as manganese acetate itself. Cerium acetate is a very stable salt, its solution when exposed to the air remains limpid and colourless, and shows no sign of spontaneous oxidation. In the course of his experiments the author finds a quite unexpected example of similar activity in the case of lanthanum, and a result of his experiments is that undoubtedly there exists a peroxide of lanthanum, a hitherto undiscovered fact. At present it is not certain whether or not this oxide corresponds to the hydrate precipitated by hydrogen peroxide. He is continuing his investigations on this matter.

Two New Methods of Synthesising the Oxyphosphinic Acids.—C. Marie.—The author gives details of two methods of synthesising oxyphosphinic acid, but the one which gives the best results rapidly and with quantitative exactness is the method in which hypophosphorous acid is used. The phosphorous acid in the same way as the phosphorous trichloride employed by Fossek only acts very slowly and always tends to give resins, especially in the presence of fatty aldehydes.

Bromo-isopyromucic Acid.—G. Chavanne.—The author's present researches, as well as those previously made, still do not enable him to definitely fix the composition of isopyromucic acid, but they seem to suggest the idea that it belongs to the group of those curious deriva-

tives of acetylacetic ether discovered by Demarçay, and whose composition has been the object of Wolf's recent researches. It would then have a formula of the form $R<\begin{matrix}C(OH)=CH-CO\\ R'\text{————————}O\end{matrix}$, and would possess a lactonic group juxtaposed to an enolic group.

Oxidation of Ammonia and the Amines by Catalytic Action.—A. Trillat.—Catalytic action takes place with great activity on ammonia, in presence of water, the ammonia being transformed into nitrite and nitrate; the amines of the fatty series are decomposed, giving products of oxidation resulting from the catalytic action on the ammonia and the alcohols; finally, in the case of the aromatic amines, the oxidation seems to take place chiefly on the chains containing alkyl groups.

MISCELLANEOUS.

Proposed Society of Electro-Chemists and Metallurgists.—We have much pleasure in drawing attention to the subjoined circular-letter, which has been sent to a large number of electricians, chemists, and other scientific men:—

82, Victoria Street, London, S.W.,
January, 1903.

DEAR SIR,—At a meeting of the Provisional Committee of the proposed Society of Electro-Chemists held on January 6th, at 82, Victoria Street, S.W., Mr. James Swinburne in the chair, it was resolved, in consideration of the support and encouragement received in response to the circulars recently issued, to hold a General Meeting of the supporters of the movement, and formally inaugurate the work of the Society and elect a President and Council. The meeting will be held, by kind permission, at the rooms of the Faraday Club, St. Ermin's Hotel, Westminster, on Wednesday, February 4th, at 5 p.m., and the pleasure of your attendance and co-operation is cordially invited. Should you be unable to be present at the meeting I shall be glad if you will kindly send me your name as an intending member of the Society, if you have not already done so. It has been suggested that there should be two classes of Members—Members and Associated Members—the subscription fees being Two Guineas and One Guinea respectively.—Yours faithfully, F. S. SPIERS, Hon. Sec. of Provisional Committee.

The following Gentlemen have kindly consented to be nominated as Members of Council of the proposed Society at the Meeting to be held on February 4th:—*President*—J. W. Swan, F.R.S. *Vice-Presidents*—Prof. A. Crum-Brown, M.D., D.Sc., F.R.S.; Sir Oliver T. Lodge, D.Sc., F.R.S.; Ludwig Mond, Ph.D., F.R.S.; Lord Rayleigh, D.C.L., F.R.S.; Alexander Siemens, M.Inst.C.E.; J. Swinburne, Pres. I.E.E., M.Inst.C.E. *Council*—George Beilby; Bertram Blount; W. R. Cooper, M.A., B.Sc.; Sherard Cowper-Coles; F. G. Donnan, M.A., Ph.D.; Prof. A. K. Huntington; F. Mollwo Perkin, Ph.D.; W. S. Squire, Ph.D.; O. J. Steinhart, Ph.D.

Royal Institution.—On Thursday next, February 5th, at 5 o'clock, Sir Clements Markham will deliver the first of a course of three lectures at the Royal Institution on "Arctic and Antarctic Exploration," and on Saturday, at 3 o'clock, Mr. A. B. Walkley begins a course of three lectures on "Dramatic Criticism." Mr. G. R. M. Murray being unable owing to illness to deliver his course of lectures beginning Thursday, February 26th, Professor L. C. Miall will instead deliver three lectures on "Insect Contrivances." The Friday Evening Discourse on February 6th will be delivered by the Right Hon. Sir Herbert Maxwell, on "George Romney and His Works"; on February 13th by Professor S. Delepine, on "Health Dangers in Food": and on February 20th by Principal E. H. Griffiths, on "The Measurement of Energy."

MEETINGS FOR THE WEEK.

MONDAY, Feb. 2nd.—Society of Chemical Industry, 8. "Statistics of British and German Chemical Trades for 1901, with Suggestions for Improving the Official Tables," by F. Evershed. "The Standardisation of Analytical Methods," by H. Droop Richmond.
—— Royal Institution, 5. General Monthly Meeting.
—— Society of Arts, 8. (Cantor Lectures). "Paper Manufacture," by Julius Hübner.

TUESDAY, 3rd.—Royal Institution, 5. "The Physiology of Digestion," by Prof. Allan Macfadyen, M.D.
—— Society of Arts, 4.30. "Technical Education in connection with the Book-producing Trades," by Douglas Cockerell.

WEDNESDAY, 4th.—Society of Arts, 8. "Methods of Mosaic Construction," by W. L. H. Hamilton.

THURSDAY, 5th.—Royal Institution, 5. "Arctic and Antarctic Exploration," by Sir Clements Markham, K.C.B., F.R.S.
—— Chemical, 8. "A New Vapour-density Apparatus" and "A new principle for the Construction of a Pyrometer, by J. S. Lumsden.

FRIDAY, 6th.—Royal Institution, 9. "George Romney and His Works," by the Right Hon. Sir Herbert Maxwell, Bart., M.P., LL.D., F.R.S.

SATURDAY, 7th.—Royal Institution, 3. "Dramatic Criticism," by Arthur B. Walkley.

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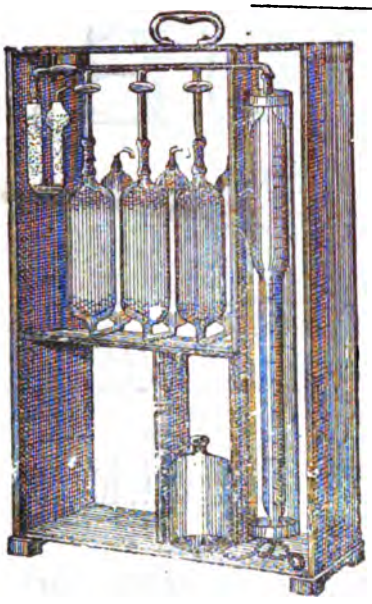

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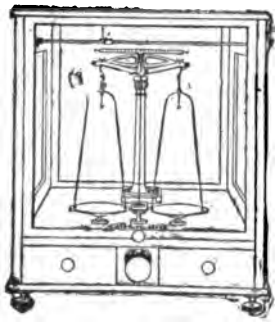

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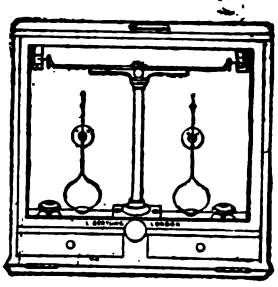

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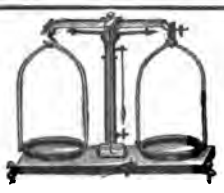

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THE CHEMICAL NEWS.

VOL. LXXXVII., No. 2254.

REVISION OF THE ATOMIC WEIGHT OF LANTHANUM.*

By BOHUSLAV BRAUNER, Ph.D.,
and
FRANTIŠEK PAVLÍČEK, Bohemian University, Prague.

(Continued from p. 52).

First Series of Determinations.

TABLE II. contains the results of the preliminary series of syntheses of lanthanum sulphate. The oxide, as well as the sulphate, was weighed after standing for half-an-hour over phosphoric oxide. The weights were carefully corrected, the method of weighing was that by vibrations, the weights are given *in air*. The standards used are O=16 and S=32·06.

In passing in review the atomic numbers obtained from the different fractions of lanthanum, they are seen to rise slowly from 138·78, corresponding with the most basic fraction La 1, to 139·08, corresponding with the least basic fraction La 7, after which follows the less pure fraction A 5+6, with a still higher atomic number 139·27. From this we might be entitled to conclude that the purest lanthanum material, which we have decomposed into eight different fractions, is not homogeneous. The difference between the highest and lowest number, 139·08−138·78=0·3, is not very considerable, but it must be said here that after resuming the work with increased refinements, two new sources of error were discovered which were removed by using a special arrangement for weighing.

New Fractionation.

In order to answer the question as to the homogeneity of our lanthanum, new methods were used for its fractionation:—

A. The purest lanthanum-ammonium nitrate was purified by a series of re-crystallisations and the atomic number was determined.

Experiment 15.—0·8262 grm. La_2O_3 yielded 1·4353 grm. of the "neutral" sulphate, SO_3=0·6091 grm., La_2O_3=57·563 per cent, whence La=138·89. This number corresponds to the mean of the above series.

B. The second method of fractionation consisted in digesting lanthanum oxide with a concentrated solution of ammonium nitrate at about 80°. The more basic portion of lanthanum may be expected to pass into solution, and the less basic portion to remain undissolved. We made use of the circumstance that the limit of this reversible reaction (which follows the law of mass action) is displaced in one direction as the temperature rises, whereas it is displaced in the contrary direction as the temperature falls. After repeating this process with the soluble portion (the reaction is reversed when ammonia is added) and with the insoluble portion very many times, the most basic fraction La α, and the least basic fraction La β were obtained. After purification from silica, &c., in the manner indicated (see p. 51), the hydroxide, oxalate, and oxide were prepared in turn, and the oxide was used for the atomic weight determination (weights *in air* are given). (See Table A).

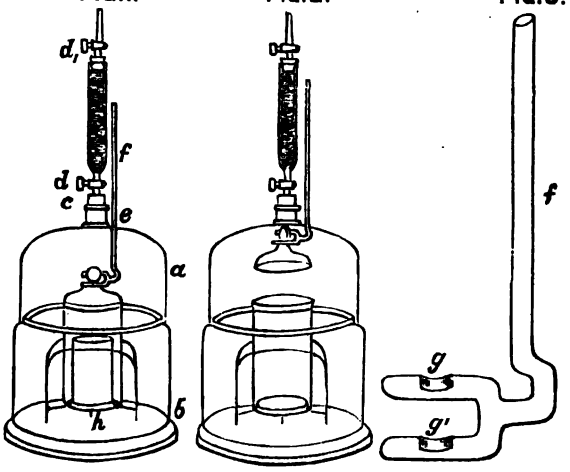
These results are opposed to those previously found. Lanthana separated from other cerite earths could not be split up into different fractions possessing a different atomic weight.

The above was the state of the experimental work when M. Pavlicek, in July, 1900, was obliged to leave the laboratory. With the intention of solving the question as to the real atomic weight of lanthanum with all possible accuracy, I undertook a further series of experiments which form a revision of the first part of this paper.

Second Series of Determinations.

It had now become obvious that the "sulphate method" of determining atomic weights is full of hidden small sources of error which were almost entirely overlooked by the earlier workers in the large series of determinations quoted in Table I., and were discovered and avoided only in this work only by degrees and not without difficulty and the sacrifice of much time. It must be remarked that the chemical method used in this part of the work was essentially the same as that described in the former part of this paper. The essential difference consisted in the manner in which the errors due to the hygroscopic nature of the material were avoided.

FIG. 1. FIG. 2. FIG. 3.



The anhydrous sulphates of the rare earths are so extremely hygroscopic that it is impossible to weigh them in a *really anhydrous* state by using ordinary desiccators containing phosphoric oxide (Nilson) or to weigh them in closed weighing vessels made of light glass (Bunsen), as was done in the first part of this work. It was necessary to avoid the absorption of any trace of moisture during the process of cooling and weighing, and this was achieved by enclosing the crucible containing the still hot sulphate in a vessel containing completely dry air so that it could not come into contact with moist air until the weighing was finished.

I succeeded in doing this by constructing a desiccator shown in the Figures 1, 2, and 3.

* From the *Transactions of the Chemical Society*, 1902, vol. lxxxi.

TABLE A.

No. of experiment.	No. of fraction.	La_2O_3.	Sulphate "crude."	Correction.	SO_3 corrected.	La_2O_3 in the sulphate.	Atomic weight La.
		Grms.	Grms.	Grm.	Grm.	Per cent.	
16.	La α	0·95652	1·66231	−0·00098	0·70481	57·576	138·98
17.	Most positive	0·45780	0·79580	−0·00015	0·33785	57·538	138·73
18.	La β	1·34754	2·34635	−0·00561	0·99320	57·569	138·93
19.	Most negative	1·17280	2·03961	−0·00157	0·86524	57·545	138·79

TABLE II.—*Syntheses of Lanthanum Sulphate. First Series (Preliminary).*

No. of experiment.	No. of fraction.	La_2O_3 (in air).	Sulphate "crude."	Correction.	SO_3 Corrected.	La_2O_3 in the sulphate.	Atomic weight La.
		Grms.	Grms.	Grm.	Grm.	Per cent.	
2.	La 1	0·93205	1·6198	Nil	0·68775	57·541	138·75
3.	La 1	0·8416	1·46366	−0·00132	0·62074	57·552	138·82
4.	La 1	0·85993	1·49518	−0·00078	0·63447	57·543	138·77
5.	La 2	0·7847	1·3635	Nil	0·5788	57·550	138·81
6.	La 2	0·80645	1·40145	Nil	0·5950	57·544	138·77
7.	La 3	1·0760	1·8707	−0·00157	0·79313	57·567	138·92
8.	La 4	1·0683	1·51479	Nil	0·7873	57·572	138·96
9.	La 5	0·8721	1·5160	−0·00151	0·64239	57·584	139·03
10.	La 6	0·9755	1·6948	−0·00099	0·71831	57·592	139·09
11.	La 6	0·9188	1·5955	Nil	0·6767	57·587	139·05
12.	La 7	0·9507	1·65212	−0·00172	0·6997	57·604	139·17
13.	La 7	0·9677	1·68194	−0·00132	0·71292	57·580	139·01
14.	A 5+6	0·8570	1·4880	−0·00064	0·63036	57·619	139·27

TABLE III.—*Syntheses of Lanthanum Sulphate. Second Series (Weights in Air).*

No. of experiment.	No. of fraction.	La_2O_3.	Sulphate crude.	SO_3 crude.	Correction.	SO_3 corrected.	Temperature.	La_2O_3.	Atomic weight of La. Apparent.	Atomic weight of La. True.
		Grms.	Grms.	Grms.	Grms.	Grms.		Per cent.		
20.	La 1	1·12533	1·95834	0·83301	—	—	510° One day.	—	138·23	—
			1·95809	0·83276	—	—	560° Two hours.	—	138·28	—
			1·95733	0·83200	—	—	560° Seven hours.	—	138·43	—
			—	0·83200	−0·00341	0·82859	—	57·5934	—	139·097
21.	La 1	1·70246	2·96305	1·26059	—	—	500° Seven hours.	—	138·17	—
			2·96227	1·25981	—	—	560° Six hours.	—	138·29	—
			—	1·25981	−0·00619	1·25362	—	57·5919	—	139·087
22.	La 1	1·02441	1·82295	0·79862	—	—	300° One day.	—	130·0	—
			1·78178	0·75737	—	—	500° Five hours.	—	138·42	—
			1·78168	0·75727	—	—	550° Eight hours.	—	138·44	—
			1·78001	0·75560	—	—	600—634° Six hours.	—	138·80	—
			1·77884	0·75443	Nil	0·75443	634—654° Seven hours.	57·5886	—	139·065
23.	La 0	1·06543	1·85312	0·78769	—	—	600—634° Half day.	—	138·43	—
			1·85125	0·78572	—	—	634—654° Two and a-half days.	—	138·82	—
			—	0·78572	−0·00133	0·78449	—	57·5933	—	139·097
24.	La 0	1·00676	1·74803	0·74127	—	—	634°± One day.	—	139·10	—
			1·74742	0·74066	—	—	654°± One day.	—	139·24	—
			—	0·74066	+0·00056	0·74122	—	57·5956	—	139·112
25.	La 7	1·06469	1·84850	0·78381	—	—	634°± One day.	—	139·125	—
			1·84820	0·78351	—	—	654°± One day.	—	139·19	—
			—	0·78351	+0·00028	0·78379	—	57·5980	—	139·128
26.	La 4	1·28627	2·23795	0·95168	—	—	634—654° Two days.	—	138·31	—
			2·23419	0·94792	—	—	>654°± One day.	—	138·96	—
			—	0·94792	+0·00074	0·94718	—	57·5912	—	139·082
					Mean in air			57·5931		La = 139·095
					Probable error of the percentage ..			±0·00076		

On the bottom of the desiccator (*b*, Fig. 1), a thick layer of phosphoric oxide is placed, and in it stands a tripod made of thick copper wire. Into this tripod is placed loosely a light weighing glass provided with a perfectly ground *conical* stopper. The cover of the desiccator (*a*) has in its centre a neck closed by a perforated rubber stopper (*c*) carrying a small drying-tube filled with anhydrous calcium chloride and provided with two stopcocks (*d*) and (d_1). At a distance halfway between the centre and the edge of the upper part of the cover (*a*), a round hole of about 8 m.m. diameter is bored, and in this is fastened by means of rubber-solution a piece of thick-walled rubber tube (*e*) through which a glass fork (*f*) may be pushed and moved in both directions in a layer of "unguentum simplex." This fork serves to open, raise, and close the stopper of the weighing glass while the desiccator remains closed. The fork (Fig. 3) possesses two horizontal transverse furrows (g g_1) into which the handle of the glass stopper exactly fits. By pushing the fork downwards so that its teeth pass the handle of the stopper, and then turning the cover of the desiccator through 90°, the handle of the stopper falls into the furrows and rests upon them. The stopper is then easily raised and its point pressed against the rubber stopper (*c*); it rests firmly, so that the cover of the desiccator containing it may be taken off and even inclined without the stopper falling out. On the bottom of the weighing glass is placed a round table made of platinum sheet and provided with three legs.

When the platinum crucible with the hygroscopic substance (for example, La_2O_3) has been heated to a yellow heat, the desiccator is prepared as seen in Fig. 2, the lid taken off, and the still red-hot crucible placed on the platinum table (*k*) in the weighing glass, which prevents the glass from coming into direct contact with the red-hot crucible. The cover (*a*), which was taken off only for a few seconds, is replaced, the expanding hot air leaves the desiccator through the drying-tube (d d_1), and, on cooling, dry air passes in through the same way, so that the atmosphere of the desiccator is in equilibrium with the outer atmosphere. Then the stopper is pushed into the weighing glass so as to *almost* close it, which is done completely after a quarter of an hour, when all has cooled down. After this, the cover of the desiccator is turned back through 90°. The substance enclosed inside the weighing glass cannot attract moisture from anywhere. The surface of the phosphoric oxide inside the desiccator must be renewed very often and fresh oxide added.

The crucible was weighed regularly half-an-hour after being placed in the desiccator, and a weighing glass of the same size as that just described containing a similar platinum crucible treated in the same way was used as a tare on the right-hand pan of the balance, both weighing flasks having nearly the same weight and displacing nearly the same volume of air, so that their coefficient of surface condensation was equal in both cases.

The weighings were made on a very fine and sensitive balance made by Rueprecht, and reconstructed for this kind of work by Nemetz, of Vienna. The balance was guarded on all sides against the influence of radiant heat, and as fractions of a grm. could be placed on the balance without the case being opened, the change of the "zero-point" or of the "state of the balance" (Mendeléeff) was only very small. The "zero-point" was not taken with the empty balance, but with carefully adjusted 50 grm. weights on each pan, this being very nearly equal to the weight of the weighing glass *plus* crucible. The method of vibrations was used, and the weights employed were most carefully calibrated, so that the errors due to weighing alone hardly exceeded ±0·00002 grm. This *physical* error is quite insignificant compared with the much greater error due to the inexactness of our *chemical* methods.

When by using the desiccator just described the attraction of moisture by the enormously hygroscopic lanthanum sulphate was reduced to a minimum, higher numbers were obtained for the atomic weight than in the first series. This is seen by comparing the results of experiments 17 and 19 obtained by M. Pavlicek by the old method of weighing, giving La = 138·73 and 138·79, with experiments 16 and 18 made by me, which yielded La = 138·98 and 138·93.

The results of this second series of syntheses are seen in Table III., and they require some explanation.

In order to be able to compare the data obtained in the different phases of the single experiments with those obtained by other chemists, the weight obtained by weighing *in air* are given in Table III., from which the "apparent" and "true" atomic weights are calculated.

For the final determinations of the atomic weight of lanthanum, the reduction to a *vacuum* was calculated by using the following data:—Density of La_2O_3 = 6·48, that of air in our laboratory d = 1·18 (1 litre = 1·18 grms.), 1 grm. La_2O_3 displaces 0·182 m.grm. of air or 1 grm. in air weighs in a vacuum 1·000182 grms. Density of $La_2(SO_4)_3$ = 3·545, 1 grm. in air weighs in a vacuum 1·000333 grms. The *vacuum numbers* with all other corrections are given in Table IV.

TABLE IV.—*Final Determinations of the Atomic Weight of Lanthanum* (*Weights in Vacuo*).

No. of fraction.	No. of experiment.	La_2O_3 grms.	$La_2(SO_4)_3$ grms.	SO_3 grms.	La_2O_3 per cent.	Atomic weight La.
La 0	23	1·06562	1·85054	0·78492	57·5842	139·036
La 0	24	1·00694	1·74856	0·74162	57·5868	139·053
La 1	20	1·12553	1·95457	0·82904	57·5845	139·038
La 1	21	1·70276	2·95707	1·25431	57·5828	139·026
La 1	22	1·02460	1·77943	0·75483	57·5802	139·009
La 4	26	1·28650	2·23419	0·94769	57·5823	139·024
La 7	25	1·06488	1·84910	0·78422	57·5891	139·068
				Mean	57·5843	139·036
				Probable error	±0·0007	

The atomic weight of lanthanum corrected to a vacuum is therefore La = 139·04.

In all experiments recorded in Table III., the temperature to which the sulphate was heated was stated as nearly as possible. It was found that even at 560°, and when the heating was carried out in an atmosphere of ammonium carbonate, the acid sulphate could not be destroyed completely, and the "apparent" atomic weight of about 138·4 was obtained; this is identical with that found by several investigators who overlooked the presence of the acid sulphate. If, however, a larger mass of the sulphate had to be heated, the inner part gave off this "half-combined" sulphuric acid less easily than when the mass of the sulphate was smaller, so that, for example, with 1·82 grms. of the sulphate the value 138·42 (experiment 22) was obtained, whereas with 2·96 grms. this had fallen to 138·29 (experiment 21).

The attempt was made to heat the lanthanum sulphate to such a high temperature that some *basic sulphate* might be formed, in order to see whether the same atomic weight would be obtained when the titration was done from the *basic side*, instead of from the acid side as hitherto. For this purpose the smaller crucible was heated inside a larger platinum crucible to a dark red heat. It was found that the sulphate assumes a visible dark red heat near the temperature at which pure potassium iodide melts, that is, 634° ± 3° (Carnelley), whereas a stronger red heat corresponded to the melting-point of silver sulphate, that is, to 654° ± 2°.

When this mode of heating was used, a "neutral sulphate" was obtained only in experiment 22, and basic sulphates were obtained only in experiments 24 and 25. On titration with N/20 sulphuric acid until all basic salt had dissolved and the neutral point was reached, the same result was obtained as when the free acid was titrated with N/30 sodium hydroxide. This agreement shows that the final residue of "half-combined" sul-

phuric acid is present in the form of the *acid sulphate* and not of that of the pyrosulphate.

It is also seen from the above experiments that normal lanthanum sulphate may be heated to a dark red heat without decomposing, for its slight decomposition begins only at about 650°±, and even near this temperature the decomposition of the *acid* sulphate is not complete.

From Table IV. it is seen that the largest deviations from the mean atomic weight are +0·03 and −0·03, and the probable error of the percentage of the oxide in the sulphate is ±0·0007, so that the lanthanum material employed may be considered *homogeneous*. With regard to the circumstance that the oxide obtained from fraction La 7 was slightly buff-coloured, as compared with the white oxide obtained from the most basic fractions La 0, La 1, La 2, La 3, and La 4, the possibility that the fraction La 7 contains a trace of an impurity which also *very slightly* raises its atomic weight, is not excluded, but even if this experiment 25 and the too low result of experiment 22 be omitted, the mean atomic weight La = 139·04 would remain unchanged. On the contrary, the lower fractions may be regarded as containing the real *pure lanthanum*.

This question was tested with a more negative and less intensely purified fraction A5+6.

Experiment 27.—0·90238 grms. La_2O_3 gave, after heating the sulphate for two days at 634°±, crude sulphate = 1·56694 grms. (apparent atomic weight = 139·07). The sulphate was acid, and the correction −0·00056 grm., therefore SO_3 = 0·66400 grm. La_2O_3 in the sulphate = 57·609 per cent, from which La = 139·20 (in air).

This result agrees with that obtained in experiment 14 of the first series, and shows that the assumption of the presence of an earth with a higher atomic weight in the less basic fractions of our lanthanum material beginning even with La 7 is not wholly unfounded.

The present series of experiments, however, did not confirm the slight variation of the atomic weight obtained from the lower fractions in the first series of experiments. The lower numbers obtained in that series, especially with the fractions La 1 and La 2, and the circumstance that the discrepancies between the first and second series gradually diminish, was found only after a long time to be due to the following reasons :—

(1) The highly hygroscopic nature of the salt. The water vapour which was attracted by the salt from an atmosphere of ammonium carbonate is given off again by the salt only after being heated for many hours at above 600°. If we stop this heating too early, the weight of the sulphate will be found *greater*, and the atomic weight *smaller*, than the truth. The same error is caused if the anhydrous sulphate is left in an ordinary desiccator, especially if it does not contain fresh phosphoric oxide and if no precautions are taken to avoid the attraction of moisture during the weighing of the salt. These two sources of error were eliminated only during the second part of the research by using the special form of desiccator.

(2) The titration of the acid sulphate in the presence of ethyl-orange is not only an *acidimetric*, but also a *colorimetric* method, which requires a well-lighted laboratory and good practice. Both were wanting during the first stage of our work. The use of this method undoubtedly lowers the standard of exactness of our work, for whereas the *weight* of the sulphate can be determined to ±0·00002 grm., the acidimetric-colorimetric method hardly allows an exactness equivalent to ±0·00005 grm. of sulphuric acid to be reached.

It is an interesting psychological fact that with increasing practice the sum of the errors due to the above sources gradually diminished, so that the results obtained during the latter part of the first series are quite free from them. This is especially the case with experiments 9, 10, 11, 12, and 13, which give a mean atomic weight almost identical with that obtained in experiments 20—26, but they are not included in the final calculation, as they would raise the value of the probable error of the mean from ±0·00073 to ±0·0012, and lower the "weight" of our atomic number. But the direction in which the errors of the first series diminish may be regarded as a proof that our present number, La = 139·04, lies near the truth.

(To be continued).

NOTE ON BOILER WATER CONTAINING SODIUM CARBONATE.

By ARTHUR E. LEIGHTON.

In recent years some attention has been drawn to waters containing sodium carbonate as a constituent, and Fisher (*Analyst*, 1901, p. 202) has pointed out how commonly such waters are yielded by deep wells in the London area.

Although this is the case, but little information is extant as to the behaviour of such waters when used for boiler purposes. Some little time ago a sample of water was received which was said to have corroded the plates and gun-metal fittings of the boiler in which it had been used. That corrosion of the boiler plates had occurred was probable by reason of the quantity of iron oxide suspended in the sample, whilst the gun-metal check valve was corroded to a depth of one-sixteenth of an inch. It might be mentioned here that the "gun-metal" used for this purpose contains zinc in addition to copper and tin. An analysis of the filtered water was made with the following result. For comparison the figures relating to the well water are given, both series being stated in N/10 c.c. per litre :—

		Well water. N/10 c.c. per litre.	Boiler water. N/10 c.c. per litre.
Combined acids	CO_2 ..	55	284
	Cl ..	40·5	524
	SO_3 ..	29·65, 125·15	399·6, 1207·6
Combined bases	CaO ..	8·70	traces
	MgO .	8·15	traces
	Na_2O	108·4, 125·25	1510, 1510·0

In the original water the combined acids and bases exactly neutralised one another, and assuming that the calcium and magnesium are present as carbonates, this water contained of sodium carbonate 14 grains per gallon. In the boiler water there was an excess of base over acid to the extent of 302·4 N/10 c.c. per litre. Actual titration with phenolphthalein and methyl orange shows caustic soda equal to 307 N/10 c.c. per litre, or a 0·12 per cent solution. This caustic soda solution has been produced by concentrating the original well water about thirteen times in a boiler working under a pressure of 120 lbs. The solution readily attacked aluminium foil in the cold. Paul (Society of Engineers, November 21, 1891) records a similar case where water originally containing sodium carbonate has, after one month's run in a boiler and becoming concentrated about fifty times, developed caustic soda. He found the solution contained 163·24 grains per gallon, or 0·23 per cent caustic soda. In this case severe corrosion of the boiler had taken place. It shows with what discrimination soda-ash should be used for water softening. No explanation has yet been given of the formation of caustic soda under these conditions, and it is not easy to persuade a manufacturer to allow experiments to be carried on, especially so when these experiments must only result in further corrosion of the boiler. The following results obtained after a short run where the water concentration reached about 2 may be of interest :—

		Well water. N/10 c.c. per litre.	Boiler water. N/10 c.c. per litre.
Combined acids	CO_2 ..	46	77
	Cl ..	38	72
	SO_3 ..	27·6, 111·6	52·1, 201·1
Combined bases	CaO ..	5·3	2·3
	MgO .	6·15	1·2
	Na_2O	100·2, 111·65	196·4, 199·9

No caustic soda had been formed. Judging from the state of the water after the last experiment, frequent blowing down of the boiler would have prevented the formation of caustic soda, but in the case under notice such treatment would have been highly inconvenient. Chemical treatment was resorted to—the "half bound" and free carbonic acid being removed by lime, and the sodium carbonate by calcium chloride.

CARBON IN HIGH-SPEED STEELS.

Amongst published methods for the estimation of carbon in steel and iron current forty years ago were some in which the carbon, after separating from the iron, was mixed with copper oxide and burned in a stream of oxygen with all the usual precautions common to the combustion of organic bodies. The use of copper oxide for this purpose has been abandoned long ago, along with many other time-absorbing or expensive modifications which were found to have no influence on the accuracy of the results obtained.

The simpler forms of the combustion process have gained the confidence of works' analysts even when applied to the assay of special steels; in fact, it is generally assumed that any steel (or alloy for that matter) which is decomposed by a solution of a double copper salt can have its carbon determined by igniting the residue and measuring the CO_2 formed.

There is evidence, however, that the high-speed self-hard steels, introduced three or four years ago and now commonly met with, are not amenable to the usual means of estimating carbon. The results are said to be low by 0·05 to 0·10 per cent when compared with those obtained by igniting the steel direct with red lead. This I can confirm, and even a greater deficiency might be attained with apparatus in all ways appropriate to the assay of normal steels.

These low results have so far been explained by the assumption that an acid solution of the double copper salt, as well as the hydrochloric acid used subsequently for washing, may decompose or dissolve a portion of the residual metallic carbides. This assumption is incorrect. It was found experimentally:—

1. That no hydrocarbons are evolved on dissolving these special steels in the usually acidified solution of copper ammonium chloride.
2. That the residual carbides contain all the carbon present in the steel weighed off; but the unusual amount of chromium and tungsten also in the residue prevents the carbon being entirely burned off except at a very high temperature, or after mixing with some oxidising reagent, such as copper oxide, lead chromate, or red-lead.

The demonstration of the second proposition alone is conclusive. It was made by assaying the steels in the usual manner, then grinding the ignited residue, mixing with red-lead, and re-igniting. The total weight of carbon dioxide obtained in these two ignitions agreed with that obtained from a direct combustion of the steel with red-lead, or with that obtained by mixing the residue at once with copper oxide as suggested in the first paragraph.

The carbonaceous residue obtained from these special steels is comparatively bulky, and is usually arranged in small compass in the boat, and frequently also under a layer of asbestos. A more nearly accurate result can be obtained by simple ignition if the residue is arranged more superficially in the boat. J. T.

Action of Methylic Alcohol on its Soda Derivative.—Marcel Guerbet.—Methylic alcohol heated with its soda derivative does not behave like the other alcohols; at 200° it remains unchanged; at 230—240° it decomposes with the production of sufficient gaseous products to cause the tube to explode.—*Bull. Soc. Chim.*, [3], xxvii., No. 12.

ARSENIC PENTACHLORIDE.*

By CHARLES BASKERVILLE and H. H. BENNETT.

The non-existence of arsenic pentachloride has for a long time been regarded as remarkable, especially so when the analogues of that element having atomic weights below and above it, phosphorus and antimony, show pentavalence toward the halogens.

Hurtzig and Geuther (*Ann. Chem. Pharm.*, cxi., 171) endeavoured to prepare it by treating arsenious acid with phosphorus pentachloride. Mayerhofer (*Ann. Chem. Pharm.*, clviii., 326) passed chlorine into arsenic trichloride at −10° C., removing the excess of chlorine by a stream of carbon dioxide, and failed to obtain the body. Janovsky (*Ber.*, 1875, viii., 1636) treated phosphorus pentachloride with arsenic trihydride at 0° C. with negative results. Dumas (*Liebig's Ann. Chem.*, xxxiii., 337) thought he had arsenic pentachloride, but Capitaine (*Journ. Pharm.*, xxv., 524) proved it to be a mixture of As_4O_6 and $AsCl_3$. Weber having prepared $SbCl_5PCl_5$, Cronander (*Ber.*, 1873, iii., 1466) sought its analogue $AsCl_5PCl_5$, but only obtained $AsCl_3PCl_5$. Marignac (*Liebig's Ann. Chem.*, cxlv., 249) obtained AsF_5 as a double fluoride of potassium. Sloane (Chemical News, 1881, xlvi., 194) prepared AsI_5, and endeavoured to secure the pentachloride by saturating arsenic trichloride with chlorine at −23° C. at ordinary pressure, and obtained the ratio As : Cl : : 1 : 4·447. There was a gradual decrease in the ratio up to 24° C., when it became 1 : 4·08, then there was an abrupt change rapidly approaching 1 : 3. Such observations made the existence of As_2Cl_8 quite conceivable.

Baeyer's pentahalogen compounds of arsenic, in which one to four chlorine atoms have been replaced by alkyl radicals, and Michaelis' (*Ber.*, viii., 1316; and ix., 1566) work with phenyl residues are well known. Recently the pentavalent organic arsenic compounds have become much augmented by the extensive work of Michaelis (*Liebig's Ann. Chem.*, 1902, cccxx., 271).

The procedure of Sloane (Chemical News, 1881, xlvi., 194) offered encouragement, provided the reaction should be carried out at a lower temperature. Chemically pure arsenic trichloride was prepared and re-distilled from concentrated sulphuric acid, and its purity determined by analysis. About 5 c.c. of the liquid were placed in a dry test-tube buried in solid carbon dioxide loosely packed in a Dewar bulb, and dry chlorine led in. The crystalline trichloride (m. p. −18° C.) assumed a greenish yellow colour and became liquid, which grew in bulk. Besson (*Comptes Rendus*, cix., 940) showed that arsenic trichloride saturated with chlorine at zero does not solidify at −30° C. Davy also showed that it does not freeze at −29° C. when well saturated with chlorine. After a few minutes, the time varying with different experiments, the stream of gas was cut off and the excess of liquid chlorine removed by fractional distillation. Chlorine boils at −33·6° C. We verified this by completely boiling away several c.c. of chlorine at −33° C. in other experiments. As a safeguard we allow the temperature to rise to −31° C. The liquid was cooled again to −35° C., and samples were removed as the temperature rose by means of a small pipette chilled to the temperature of the refrigerating agent. These samples in one experiment were placed directly in water; in another it was deemed better to place them in a dilute sodium hydroxide solution. In the former case immediate solution occurred with those portions removed at temperatures below −25° C., while at those higher a white precipitate, evidently of arsenious oxide, formed, increasing in amount with elevation of temperature. The orthoarsenic acid was determined as magnesium pyroarsenate and chlorine as silver chloride. The filtrate from the magnesium ammonium arsenate in the former was tested for the presence of arsenious compounds.

* Contribution from the Chemical Laboratory of the University of North Carolina. From the *Journal of the American Chemical Society*, vol. xxiv., No. 11.

None were found up to −25° C., when arsenious acid was found in traces increasing in amount with rise of temperature. The ratio between arsenic as arsenic acid, and chlorine, was 1 : 5 or $AsCl_5$. At −25° C. the ratio rose to 1 : 6. The loss of chlorine, and consequent return to the trivalent condition, became more and more marked, the higher the temperature.

The following analytical results were obtained for two temperatures in one experiment:—

Temperature. °C.	Amount taken.	Chlorine found. Per cent.	Theoretical.	Ratio obtained. As : Cl.
−35	0·1796	69·93	70·26	1 : 4·93
−25	0·26675	73·21	—	1 : 5·78

Arsenic pentachloride is readily soluble in carbon disulphide and absolute ether cooled to −30° C. From the latter, when chilled several degrees, it crystallises in yellow prisms. It loses chlorine when heated above −28° C. On exposure to the air it fumes, evolving hydrochloric acid vapour, and as the temperature rises forms crystals, most likely of the trichloride, which melt soon to the liquid state. A special preparation was made and sealed in a tube. The greenish yellow liquid when cooled to −38° or −40° C. (we had no thermometer for determining this accurately) formed beautiful yellow crystals.

It is not regarded necessary to give our several unsuccessful preliminary experiments to secure the body for analysis. Suffice it to say that placing the body in a pipette or weighing-bottle at the temperature of the air brought about its immediate decomposition to the original trichloride, chlorine being evolved.

AN OCCURRENCE OF FREE PHOSPHORUS IN THE SALINE TOWNSHIP METEORITE.

By OLIVER C. FARRINGTON.

On drilling into the Saline Township meteorite* recently for the purpose of breaking off a piece, a white "smoke" was observed by the writer to rise from the drill-hole when a depth of a little over two inches (5·5 c.m.) had been reached. This "smoke" had a pungent, garlic-like odour, which was recognised as similar to that of white phosphorus. It was more pungent and resembled the odour of burning arsenic to some extent, but on the whole suggested that of phosphorus more. It was at once surmised that phosphorus might exist in the free state in the meteorite, and the supposition was soon confirmed by the following tests:—

1. On shielding the eyes from the light and looking into the drill-hole, a luminous spot could plainly be seen at the bottom. This spot on further observation showed itself to be actually made up of two. One of these was fixed and central and the other moved around it, making a revolution every two or three seconds. This motion corresponded to the swirling movement with which the fumes rose from the hole, and doubtless represented the manner of supply of air to fresh portions of the phosphorus.

2. On holding a strip of paper saturated with silver nitrate in the fumes it turned black in a few moments.

3. On treating some of the powder from the drilling with nitric acid and adding the solution so obtained to ammonium molybdate, the familiar yellow precipitate of ammonium-phospho-molybdate was produced.

The fumes continued to rise from the hole for about two hours, when they gradually diminished in volume and disappeared. The odour could, however, be detected eighteen hours afterward. These observations were confirmed by several of my associates. No effort as has yet been made to obtain a quantitative determination of free phosphorus in the meteorite, nor is it likely that results of any particular value could thus be gained. Two holes were drilled the same depth as the first in other parts of the stone, but from neither was any repetition of the above-named phenomena observed. The phosphorus is (or was) probably, therefore, only locally distributed and in small quantity. The stone where broken at the end of the hole first drilled shows a spot about half-an-inch in diameter differing considerably in colour from the rest of the stone, being brownish-white in contrast to the greenish-black hue of the remainder. This portion may prove on further examination, therefore, to be differently constituted. The properties above described are those of free phosphorus, however, and the observations leave no doubt that it existed in the meteorite. This seems to be the first known instance, then, of finding this element existing in the free state in nature.

The occurrence serves to point several conclusions regarding the origin of meteorites, which, while they do not differ from those now generally held by students of these bodies, emphasise opinions which have at times been disputed. First, the meteorite was not formed upon the earth. Second, free oxygen was not present where it was formed. Third, the interior of the meteorite cannot have been subjected to any high degree of heat since its aggregation in the solid state.—*American Journal of Science*, [4], xv., No. 85.

* For a brief account of the fall and general characters of this meteorite see *Science*, N. S., vol. xvi., p. 67, July 11, 1902.

ON THE DETERMINATION OF LEAD IN ORES.*

By IRVING C. BULL.

(Concluded from p. 54).

Summary of Results.

The accompanying is a table of the results on the different ores as obtained by the various methods described; also a table of the interferences as they occur in each of these methods of analysis.

These results are percentages of lead.

First line = milligrms. of lead taken.

Second line = milligrms. of designated impurity taken.

Third line = milligrms. of lead found by use of designated method.

Fourth line = percentage of error (high = + or low = −) in terms of lead.

Conclusions.

After carefully reviewing the tables of results obtained on the ores and by weighted additions of impurities, it becomes evident by the nature of the closely agreeing results upon the ores that there are four volumetric methods for lead that should receive attention, namely, the molybdate or Alexander's, the dichromate or back titration with either a ferrous salt or by "hypo.," Koenig's, and the ferrocyanide.

By an examination of the interference table, we must at once conclude that the dichromate is more liable to be inaccurate than any of the others, unless a great deal of time is spent in washing out the foreign chromates which in many cases are sparingly soluble, therefore requiring a great deal of time.

Koenig's method is the one method where an inside indicator makes it advantageous; it is also fairly rapid to manipulate, and gives, with ordinary amounts of impurities, good results; however, in some ores erroneous results are quite apt to occur.

The methods which give very good results even in the presence of extraordinary amounts of impurities, are the

* Contribution from the Havemeyer Laboratories, Columbia University. From the *School of Mines Quarterly*, xxiii., No. 4.

Number of ores.	Fire assay.	Lead sulphate method.	Lead chromate method.	Electro-method.	Alexander's method.	Koenig's method.	Oxalate method.	Dichromate ferrous method.	Dichromate "hypo." method.	Ferrocyanide method.
I.	76	78·68	78·71	78·73	78·74	78·60	77·54	78·71	78·76	78·67
	—	78·62	78·68	—	78·82	78·64	77·60	78·78	78·73	78·65
II.	37	37·20	37·28	37·35	37·41	37·38	36·71	37·32	37·33	37·31
	—	37·26	37·30	—	37·44	37·40	36 62	37·38	37·37	37·29
III.	9	10·76	10·77	10·80	10·80	10·58	9·92	10·78	10·80	10·90
	—	10·74	10·74	—	10·83	10·62	9·98	10·72	10·76	10·86
IV.	24·7	18·40	18·45	18·58	18·47	18·46	17·54	18·48	18·50	18·44
	Base metal	18·43	18·40	—	18·51	18·42	17·65	18·44	18·45	18·48
V.	26·7	27·25	27·23	27·32	27·44	27·24	26·28	27·31	27·26	27·25
	—	27·21	27·20	—	27·35	27·26	—	27·27	27·32	27·18
VI.	37·8	38·50	38·47	38·60	38·66	38·60	37·38	38·46	38·57	38·65
	—	38·54	38·50	—	38·58	38·68	—	38·52	38 60	38·58

	Ferrocyanide.					*Dichromate Ferrous.*					*Koenig's.*					*Alexander's.*				
Antimony.	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	25	50	100	200	400	25	50	100	200	—	25	50	100	200	400	50	50	100	120	200
	300	300	300	300	300	313	342	351	405	—	300	300	300	300	300	300	300	300	300	300
	0	0	0	0	0	+4·1	+12·	+14·	+26·	—	0	0	0	0	0	0	0	0	0	0
Bismuth.	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	25	50	100	200	400	25	50	100	200	400	25	50	100	200	400	25	50	100	200	400
	300	301	304	305	306	310	323	349	421	563	300	300	300	300	300	300	300	300	300	300
	0	+0·3	+1·3	+1·6	+1·8	+2·	+7·	+13·	+28·	+46·	0	0	0	0	0	0	0	0	0	0
Barium.	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	12	25	50	100	200	12	25	50	100	200	12	25	50	100	200	12	25	50	100	200
	301	302	305	306	306	320	337	371	402	481	310	314	330	352	368	298	295	277	256	244
	+0·3	+0·6	+1·6	+1·8	+1·8	+6·6	+10·9	+19·	+25·	+38·	+3·2	+4·	+9·	+14·	+18·	−0·6	−1·6	−6·	−10·	−15·
Strontium.	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	25	50	100	200	400	25	50	100	200	400	25	50	100	200	400	25	50	100	250	200
	300	300	300	300	300	306	311	323	342	356	320	334	414	494	560	300	300	297	289	283
	0	0	0	0	0	+1·8	+3·5	+7·	+12·	+16·	+6·	+10·	+33·	+39·	+46·	0	0	−1·	−3·6	−5·9
Calcium.	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
	25	50	100	200	400	25	50	100	200	400	25	50	100	200	400	25	50	100	150	200
	300	300	300	300	300	303	305	313	328	351	300	304	352	450	520	300	300	300	300	300
	0	0	0	0	0	+0·9	+1·6	+4·1	+8·2	+14·	0	+1·3	+14·	+33·	+42·	0	0	0	0	0

ferrocyanide and Alexander's methods. Both have the disadvantage of having outside indicators, where allowances must be made very carefully in order to get agreeing duplicates in analysis. The time required for the manipulation of either method is about the same, *i.e.*, about one hour, either requiring less time than any of the methods before discussed.

In concluding, therefore, the preceding work points out quite conclusively that the ferrocyanide titration method is at least one of the best methods for a lead assay in the wet way that is known at present, not only as regards rapidity, but also by its accuracy, having even a slight preference over Alexander's molybdate method in so far as interfering elements are concerned.

This work was undertaken at the suggestion of Professor Edmund H. Miller, and carried out under his supervision and guidance.

I take this occasion, therefore, to express my appreciation to him for his advice as well as the kind assistance which he has rendered during the work.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Ordinary Meeting, January 23rd, 1903.

Prof. S. P. Thompson, President, in the Chair.

A paper "*On an Oscillating Table for Determining Moments of Inertia*" was read by Mr. W. H. Derriman.

The apparatus consists of a circular wooden table which can be suspended from a wire by means of brass supports. A pointer is attached to the centre of the bottom of the table, and immediately below is another fixed pointer. In the top of the table a circular groove is cut, in which pieces of lead can slide. These pieces of lead form together half of a circular ring of rectangular cross section. The body, the moment of inertia of which is required, is placed in position on the table and the lead weights moved until the two pointers are opposite to one another. The table therefore always oscillates about the same axis, and since the lead weights are at a fixed distance from this axis the moment of inertia of the table remains constant. The apparatus can be employed for determining the moment of inertia of a body about any axis, and is useful for proving the law that the moment of inertia of a body about any axis is equal to its moment of inertia about a parallel axis through its centre of gravity together with the moment of inertia of the whole mass, collected at its centre of gravity, about the given axis. An experimental verification of this law is given in the paper, the values of d^2 being plotted against the corresponding values of t^2. The results are correct within about 3 per cent, and the points fall upon a straight line. The moment of inertia of the table itself can be found with the aid of a body of known moment of inertia, or it can be obtained from a series of observations upon any body placed at different positions on the table.

Mr. Skinner described an inertia balance by means of which moments of inertia can be determined without the use of stop-watches. The table which carries the body is suspended by a wire. Fixed to the centre of the bottom of the table there is another wire, similar to the first, but twice as long. This wire carries a screwed brass bar, the axis of the bar being at right angles to the wire. At the middle point of this wire there is a pointer fixed at right angles to it, and on the brass bar are two weights which can be placed at varying distances from the axis. To the bottom of the bar is attached a fourth wire, the same length as the first one, and its lower end is clamped. By arranging so that the upper table oscillates to the left when the bar is oscillating to the right, and adjusting the weights on the brass bar until the pointer is stationary, the moments of inertia of bodies placed upon the table can be determined.

The Chairman referred to an inertia table designed by Prof. Perry in which an aluminium ring was supported by a trifilar suspension.

A paper entitled "*Note on an Elementary Treatment of Conducting Networks*," by Prof. L. R. Wilberforce, was read by Mr. Derriman.

In this paper the author shows that the well-known reciprocal relations between the parts of a conducting network can be readily established without an appeal to the properties of determinants. The fact that there is no continuous accumulation of electricity at any point gives a series of equations of a certain type, and the application of Ohm's law to every branch of the network gives a second series of another type. These equations are written down for two different sets of external currents and internal electromotive forces, and a general equation is obtained from which the ordinary reciprocal relations follow as particular cases.

Mr. T. H. Blakesley said the results were well known and were proved by Maxwell by a more complicated method. He pointed out that if any two conductors in a network are considered, then the rest of the network can be replaced by four suitable resistances joining the ends of the two conductors.

A paper "*On the Theory of the Quadrant Electrometer*" was read by Mr. G. W. Walker.

For the purpose of some experiments which the author is taking up he has found it necessary to examine carefully the theory of a symmetrical quadrant electrometer, and the results of his investigations are put forward in this paper. The late Dr. John Hopkinson pointed out the imperfection of the usual formula given by Maxwell, and also gave an empirical formula which closely represented his experiments. The general result is well known, namely—that the sensibility of the electrometer rises to a maximum as the potential of the needle is raised, and that any further increase in the potential of the needle reduces the sensibility. The author's experiments have been made with a sensitive electrometer by Bartels, of Göttingen, which shows a maximum sensibility when the potential of the needle is about 100 volts. The sensibility seems to go on diminishing after this, at least until very high voltages are used. The formula for a quadrant electrometer is investigated more rigidly than in the text-books, and an equation is arrived at which is practically identical with the empirical formula of Hopkinson, and which represents exactly the results obtained by the author from a Bartels' electrometer. The equation contains a constant which must be positive to explain the results, and it is shown that this is the case. An investigation is then undertaken to obtain a numerical value for this constant. The solution of the electrical distribution for a system like the quadrant electrometer is very difficult, but the author discusses and solves a similar two-dimensional problem which confirms his view that the air-gap is sufficient to account for a maximum sensibility depending upon the potential of the needle. The ordinary formula would be more nearly obeyed with a small air-gap. It is pointed out that, although diminishing the air-gap raises the potential of maximum sensibility, it does not follow that higher sensibility is obtained by reducing the air-gap. The author then discusses the results obtained by Ayrton and Sumpner from a White electrometer with a bifilar suspension, in which the variation in sensibility is shown to be due to want of symmetry. He states that this effect is not the same as that observed by Hopkinson, and that their experiments probably apply to an extremely unsymmetrical instrument of comparatively low sensibility, and that the maximum considered in this paper is beyond the range of their instrument.

Mr. Addenbrooke stated that he had studied the quadrant electrometer from a practical point of view for

many years. He looked upon Hopkinson's paper read before the Physical Society in 1885 as the basis of all work upon the electrometer. Hopkinson pointed out that in a White instrument the deflection was proportional to the potential difference between the needle and the quadrants up to certain voltages, and ascribed the variations in sensitiveness at high voltages to want of symmetry. Mr. Addenbrooke said that there were many things which might affect the rule that the sensibility was proportional to the potential of the needle. The field is not uniform between the quadrants, the tilting of the needle may be serious, and there may be lateral displacement if the needle is not centrally suspended. In practice the distance between the quadrants must not be too small, and the needle should be as heavy as possible. He thought that the sensitiveness of different electrometers similar to the one used by the author in his experiments would vary considerably. There was always a difficulty with regard to contact-errors when working with very sensitive electrometers, but it was generally possible to get rid of it by balancing. He pointed out how the formula usually employed with a quadrant electrometer could be simplified by arranging so that the potential of one set of quadrants was as much above zero as that of the other set was below.

Mr. Appleyard said that the sensibility of the instrument was increased by doing away with the sulphuric acid and connecting wire. The effect of the surface-tension in the White electrometer was variable, and depended among other things upon the strength of the acid.

Dr. A. Griffiths indicated an improved method of arriving, in an elementary manner, at the ordinary formula for the quadrant electrometer by considering the electrical energy per unit volume instead of the capacity per unit length.

The Society then adjourned until February 13th, when the Annual General Meeting will be held.

NOTICES OF BOOKS.

A Research on the Eucalypts, especially in regard to their Essential Oils. By Richard T. Baker, F.L.S., and Henry G. Smith, F.C.S. Sydney: W. A. Gullick. 1902. Pp. 295.

With most English readers the word *Eucalyptus* does not cover a very wide field; we think of the "Blue Gum" and the "Red Gum" trees, not knowing that these are simply two species of an enormous family. In this volume the authors have divided the Eucalypts into seven principal groups and 110 species, besides varieties, all of which are probably descended from the original prehistoric *Angophora*. The authors point out that the comparative constancy of the specific characters among the Eucalypts is only what might be expected, when it is assumed that the continent of Australia is one of, if not the oldest, on the earth, having evidently remained stationary during certain subsidences and upheavals of other parts of the earth, and so preserved the fauna and flora of past geological times. During the enormous period thus represented, the species have differentiated materially from the parent stock, but the variations are comparatively few when the extensive range of the gums is considered.

With the exception of about half-a-dozen all the Eucalypts enumerated in this work will be found to possess comparatively constant botanical characters throughout their geographical distribution.

The bulk of the volume is taken up with the systematic description of the species and their essential oils; the sequence of the species is based on both botanical and chemical results, and on page 273 there is a table giving the average yields of oil obtained from the several species of Eucalypts during this research. It appears that the variation in the amount of oil in the leaves of any species of *Eucalyptus* is more largely due to the season of the year than to external conditions of rain or other weather; the largest amount is obtained in the spring time, but it has been found that in those species giving an oil rich in eucalyptol, this oil becomes richer in that constituent as the oil decreases in amount. The increase in yield is due largely to the increase in the terpenes, such as pinene and phellandrene, and it appears to be conclusive that as the year progresses the constituents first formed, in some species, change their character and tend toward the formation of eucalyptol. Nearly 500 distillations were made on an aggregate amount of nearly forty tons of leaves, and the average yield per 1000 lbs. of leaves varied from 33 lbs. 15 ozs., or 3·393 per cent in the case of the *Eucalyptus amygdalina*, to 1 oz., or 0·008 per cent, for the *Eucalyptus rubida*.

Other tables give the solubilities of the crude eucalyptus oils in alcohol, and the aggregate results of the crude oils of the various species.

The value of a research of this magnitude is very considerable, and the authors are to be congratulated on the success they have already achieved, but, as they point out in the preface, there is still a great deal more to be done.

The book is adorned with a number of excellent plates, many of them being from original drawings by Mr. R. T. Baker.

Secondary Batteries: their Theory, Construction, and Use. By E. J. Wade. London: *The Electrician* Printing and Publishing Company, Ltd. 1902. Pp. 492.

Gaston Planté was the first to investigate polarisation phenomena with a view to their utilisation rather than their elimination, his researches in this direction dating back to the year 1859. As a result of his investigations he produced a more or less practical storage battery, but it was not until 1881, when M. Faure brought out his patent for using oxides or other salts in the manufacture of the plates, that the storage battery took a commercial form.

Storage batteries as used at present are the same in principle as the original Planté cells, the only difference being in the improvements effected in the details of construction, and the methods of manufacture and treatment.

There have been, however, numerous attempts to bring into practical shape other combinations than the lead/lead-peroxide cell, with a view to getting greater storage capacity in proportion to their weight, but of these only the zinc/lead-peroxide acid cell, and the zinc/copper-oxide alkaline cell have gone so far as to be tested on a large scale, and they have been abandoned hitherto owing to their instability and rapid deterioration. A number of these cells are described in Chapter III., and though it is interesting reading no really practical results have yet been achieved.

The succeeding chapters deal entirely with lead cells, their properties and behaviour, their chemistry, their design and manufacture, their treatment and testing, their erection, connecting up, and regulation; in fact, all the information there is with regard to storage batteries seems to be included in this volume, and we most cordially commend it to all those whose work or interest lies in this direction.

Perhaps the most important chapter is No. X., on "Present-day Cells"; among these will be found the "E.P.S.," the "Crompton-Howell," the "Chloride" (both English and American), and many others. With regard to present-day accumulators, other than lead/lead-peroxide ones, the one most talked about is the "Edison," consisting of iron, and nickel oxide in an alkaline electrolyte; since the publication of the patent in the early part of 1901, the author states that he has not been able to obtain any further information, but its commercial application seems, he thinks, as far off as ever. The book is provided with two indices, one for the names of cells and electrodes only, and the other a general index.

OBITUARY.

Sir GEORGE GABRIEL STOKES, Bart.

By the death of Sir George Stokes, which occurred on Sunday last, February 1st, at his residence, Lensfield, Cambridge, Science loses one of its most distinguished men, whose death will be mourned in scientific circles throughout the world. Sir George Stokes was pre-eminently a mathematician, and as such he was second to none in this country.

But distinguished as he was, and with his time fully occupied, Sir George Stokes was always willing and able to extend a helping hand to those who appealed for his advice; he would patiently listen to their difficulties and then give of his best, and, further, he would not dismiss the matter from his thoughts when the first letter was answered, but would ponder over the problem presented to him, and would write a second and third letter, if necessary, until he felt that he had really given the assistance required.

During the time of his Secretaryship of the Royal Society, Sir George was also Editor of the *Philosophical Transactions* of the Society, and here again his rare ability asserted itself; he was editor in very fact, and many a paper was considerably improved and altered through his kindly suggestions, and its value greatly increased thereby.

George Gabriel Stokes was born at Skreen, county Sligo, on August 13th, 1819; he was educated at Dr. Wall's school at Dublin, and at Bristol College. Proceeding to Pembroke College, Cambridge, he eventually graduated as Senior Wrangler in 1841, and was elected to a Fellowship; this he vacated on his marriage in 1857, but was re-elected under the new statute in 1869. In 1849 he was appointed Lucasian Professor of Mathematics, and in 1852 he was awarded the Rumford Medal by the Royal Society (of which he had been elected a member shortly before), in recognition of his services to the cause of science by his discovery of the change in the refrangibility of light. In 1854 he was appointed one of the secretaries of the Society, and was elected President in 1885, and held this post until 1890.

In 1889 he was created a baronet in recognition of his services to Science; he received also honorary degrees from his own University, as well as from Oxford, Edinburgh, Dublin, Glasgow, and Aberdeen. In the year 1869 Sir George was President of the British Association at the meeting at Exeter, and in the following year he was appointed on the Cambridge University Commission.

On the death of Mr. Beresford-Hope in 1887 he was returned as one of the Members of Parliament for Cambridge University, and sat in the House until 1892.

The celebration of the jubilee of Professor Stokes took place three and a-half years ago, and though it is a fact that other professors had occupied their chairs for more than fifty years, still it was felt that no other professor had attained such world-wide distinction, and the celebration was accorded by the unanimous vote of the Senate.

Sir George Stokes was buried at Cambridge on Thursday, February 5th.

On the Blue Colour taken by certain Mushrooms of the Genus "Boletus."—G. Bertrand.—The author finds that the production of different colours has its explanation in the fact that the quinonic compound derived from boletol is itself of a reddish colour, while its metallic compounds are blue. According to his observations, the turning blue of the mushrooms necessitates the co-operation of six different factors: oxygen and boletol; laccase; manganese, which is generally present in the latter body; water, which acts both as a solvent and as the necessary hydrolysing agent; and, finally, an alkaline metal, magnesian or alkaline-earthy.—*Bull. Soc. Chim.*, Series 3, vol. xxvii., No. 10.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 2, January 12, 1903.

Some New Halogen Derivatives of Right-handed Benzylidene and Benzylcamphors.—A. Haller and J. Minguin.—The product formed by the addition of hydrobromic acid to benzylidenecamphor can be sharply distinguished from its isomers the benzyl-bromocamphors by the fact that phenyloxy-homocampholic acid is produced by rupture of the radicle in the former case, and in the latter case, under the same conditions, only the benzylidenecamphors are formed. The authors also find that during the action of excess of bromine on benzylcamphor the β-bromobenzyl-bromocamphors are first formed having the configuration of those benzyl-bromocamphors which, under the action of alcoholic potash, give rise to the β-bromo-benzylidenecamphors. These latter bodies by their extraordinary rotatory power are considered as benzylidenic derivatives of camphor. It is found, however, that the presence of bromine in the benzenic radicle apparently lessens to a certain extent the rotatory power. The authors are further researching on these substances.

Two Silicides of Manganese.—P. Lebeau.—The two silicides of manganese, $SiMn_2$ and SiMn, can both be obtained by the action of manganese on siliciuretted copper. The reaction may be considered as corresponding to the chemical equilibrium produced in the elementary system copper, silicon, and manganese. In a further communication the author intends to show how an investigation of these equilibriums leads to the preparation of the compounds of silicon and a metal, and how a third manganese silicide can be obtained.

Dilatation of Tempered Steel.—Georges Charpy and Louis Grenet.—In a former research the authors found the dilatation of steels having different compositions. They now continue their investigations, and by the same method find the dilatations of specimens of steel tempered under different conditions. Their experiments apparently show that the effects of tempering on the phenomena of dilatation are not affected by variations of mechanical properties or by the points of transformations indicated by the various methods. These facts seem difficult to reconcile with the theory often stated that empering acts on the properties of the steel principally by maintaining the carbon in a state of solid solution, or the iron in an allotropic state differing from the stable state in the cold. The authors' results seem to show that actions of a different order intervene.

Chloride of Cinnamylidene.—Ernest Charon and Edgar Dugoujon. — The preparation of chloride of cinnamylidene by the action of phosphorus perchloride on cinnamic aldehyde has been tried without success by Cahours, an indistillable and non-crystalline oil only being obtained. The authors once more take up this investigation to see if the chloride obtained, which ought to have the formula $C_6H_5—CH=CH—CHCl_2$, would not show the special characteristics which M. Charon has already described. The negative character of the group, $C_6H_5—CH=CH—$, is very marked in this compound. They therefore modify Cahours' preparation, and succeed in obtaining cinnamylidene chloride in a tolerably pure state.

Action of Sodium on 1.3-Iodine Phenoxypropane. Diphenoxyhexane.—J. Hamonet.—During his researches on 1.4-butanediol the author observed a peculiar reaction with certain metals on bromated or even iodated phenoxyethane. Instead of the diphenoxybutane expected, there was produced the bromide and phenate of sodium.

Bulletin de la Société Chimique de Paris.
Series 3, Vol. xxvii., No. 12.

A New Method for the Preparation of Oxygen from Oxylith.—G. F. Jaubert.—Already noticed.

A Preparation of Gaseous Phosphide of Hydrogen.—F. Bodroux.—Already inserted.

The Complex Salts of Osmium; Osmyloxalate of Potassium.—M. Vèzes and L. Wintrebert.—Already inserted in full.

Action of Ethylic Alcohol on Ethylate of Baryta. Synthesis of Normal Butylic Alcohol.—Marcel Guerbet.—By heating a concentrated solution of ethylate of baryta in absolute alcohol to 230—240° a small quantity of normal butylic alcohol is formed, and, at the same time, ethylene, hydrogen, and acetate and carbonate of baryta. The concentrated ethylate of baryta is prepared by dissolving caustic baryta in the cold in absolute alcohol, and heating the solution to boiling-point. Ethylate of barium, which is less soluble hot than cold, is precipitated, and it suffices to decant the greater part of the supernatant alcohol to obtain a concentrated solution of ethylate of baryta. This solution is placed in sealed tubes, and heated to 230—240° for twenty-four hours three separate times. At the end of each twenty-four hours the tubes are opened to allow the gas to escape, then sealed up again. The gas thus produced is passed through a series of five wash-bottles containing successively water, bromine, solution of soda, concentrated sulphuric acid, and absolute alcohol; it is then collected over water. The bromine absorbs the ethylene, the soda the fumes of bromine, the sulphuric acid dries the gas, and the alcohol dissolves the methane which is formed by the pyrogenous decomposition of the ethylate of baryta; the residual gas is hydrogen only. The contents of the sealed tubes are distilled on an oil-bath to dryness; the distillate is rectified, and passes over between 76° and 130°; after rectifying a large number of times, a small quantity of liquid is separated at length, boiling at 115—117°; this is normal butylic alcohol, $C_4H_{10}O$.

Action of Normal Propylic and Butylic Alcohols on their Respective Soda Derivatives. Synthesis of Dipropylic and Dibutylic Alcohols.—Marcel Guerbet.—Already noticed.

Mixed Imidodithiocarbonic Ethers.—Marcel Delépine.—Already noticed.

Action of the Halogen Ethers on the Sulphocarbonic Compounds of the Secondary Amines.—Marcel Delépine.—Already noticed.

The Variation of the Rotatory Power of the Ether Salts of the Stable levo-borneol.—J. Minguin and E. Grégoire de Bollemont.—Already noticed.

Condensations with Zinc and Iodacetate of Ethyl.—L. Téry.—The author has examined the reactions of iodacetate of ethyl on various substances in the presence of zinc; with β-methylcyclohexanone he obtained methylcyclohexanolacetate of ethyl; with pulegon he obtained pulegol acetate of ethyl, $C_{14}H_{24}O_3$; with citral, citralidene acetate of ethyl, $C_{14}H_{22}O_2$, from which he obtained citralidene acetic acid, $C_9H_{15}—CH=CH—COOH$, very easily by saponifying with alcoholic potash. After saponification there remains an alkaline solution which is shaken up with ether, in which a substance with a strong aromatic odour, resembling sandal-wood, is slightly soluble.

Some Reactions of Fenone.—E. Tardy.—Fenone is capable of forming numerous molecular compounds, notably with the phenols. These compounds are exothermic, and the reaction has the effect of increasing the rotatory power; the most interesting of these compounds are the naphthofenones, bodies which are perfectly crystallised. Another property of fenone is that it dissolves nitrocellulose. A mixture of 1 part of nitrocellulose and 2 parts of fenone forms a gelatinous mass; 10 per cent of fenone in alcohol will dissolve gun-cotton, giving a kind of collodion.

Action of Isocyanate of Phenyl on the Ethers of some Oxyacids.—E. Lambling.—The author has examined the action of isocyanate of phenyl on α-oxybutyric ether, on normal α-oxyvalerianic ether, and on α-oxyisovalerianic ether, and gives the results of his experiments in detail, with the analysis of the products obtained.

Some Salts of Antipyrine.—A. Reychler.—When we evaporate an aqueous solution of antipyrine, treated with a slight excess of hydrochloric acid, a syrupy residue is obtained showing hardly any signs of crystallisation. To obtain a better result, 30 grms. of antipyrine, 50 c.c. of alcohol, and 20 c.c. of strong hydrochloric acid were concentrated on the water-bath; the residue was treated with a further quantity of alcohol and acid, and re-evaporated; the mass formed was eventually freed from moisture by washing it with alcohol and ether, and, finally, with pure ether; the body formed is chlorhydrate of antipyrine, $C_{11}H_{12}ON_2.HCl$; it is barely soluble in benzene, but fairly so in a boiling mixture of 5 parts of benzene to 1 part of absolute alcohol. On cooling, an abundant crop of prismatic crystals is obtained, containing benzene of crystallisation. The author has also prepared the camphorsulphonate of antipyrine; it is very soluble in water though not deliquescent; it can be re-crystallised with ease from a mixture of 1 part of absolute alcohol and 4 parts of acetone in the form of hard compact prisms, fusible at 166°.

The Acids of "Bignonia Catalpa."—A. Piutti and E. Comanducci.—The authors find that the fruit of the "Bignonia catalpa" gathered when unripe does not contain $C_{14}H_{14}O_3$ (Sardo's catalpic acid), but *p*-oxybenzoic acid and the compound of *p*-oxybenzoic and protocatechuic acids.

The Estimation of Urea in Urine.—Ch. Sallerin.—The author has compared various methods, and finds amongst other things that Braunstein's method with the hydrolysis of the urea for seven hours at 150—155° is the best, and he used it to check the accuracy of other more simple methods.

Microchemical Analysis of some Alkaloids.—M. Surre.—Not suitable for abstraction.

Estimation of Glycerin by means of Iodic Acid in the presence of Sulphuric Acid.—A. Chaumeil.—Inserted in full.

The Conditions in which the Starch exists in New Bread and in Stale Bread.—M. Lindet.—The alimentary examination of bread has been devoted, up to the present, rather to the gluten than the starch, though it is more from the state in which the starch exists that we should expect to obtain information as to its assimilation. Under the influence of the moist heat of the oven the starch undergoes all conditions of gelatinisation down to that of soluble starch or amylodextrine. The insoluble portion is partially soluble, however, in very dilute hydrochloric acid, also in the form of amylodextrine, from which it is possible to determine the degree of gelatinisation. With regard to the actual composition of new and stale breads, the author gives a number of analyses which show that the composition of the crust is invariable; the amount of dextrine is greater than in the crumb; the starch is broken down, but is not even partially soluble in dilute acid. On the other hand, there are many transformations in the crumb. The weight of soluble dextrines is as much as 10 per cent in bread just leaving the oven; this weight diminishes progressively on keeping until it reaches only 2 per cent after forty-eight hours; it is the amylodextrine that has retrograded.

MISCELLANEOUS.

The American Electro-chemical Society.—In the last number of the Chemical News (vol. lxxxvii., January 30th, 1903) we announced the proposed formation of a Society of Electro-Chemists and Metallurgists: in this connection we may mention that we have received since then a pamphlet setting forth the preliminaries connected with the formation of the "American Electro-chemical Society." The first meeting was held on November 1st, 1901, at the Engineers' Club, Philadelphia, and as a result of this meeting the first general meeting of the proposed Society was called for April 3rd, 4th, and 5th, 1902, at Philadelphia, and Committees were appointed to enrol members and secure papers. At the meeting on April 3rd the Society was organised under the Presidency of Professor Joseph W. Richards, Ph.D., while a number of distinguish scientific Americans filled the offices of Vice-Presidents, Board of Managers, Secretary, and Treasurer. On Friday, April 4th, a number of papers were read and discussed, of which one of the principal ones was entitled "A University Course in Electro-chemistry," by Professor Richards. The author went over the ground already covered by the courses in chemistry, metallurgy, and electrical engineering, and pointed out where they would and would not be satisfactory as a preparation for the course in electro-chemistry. He is of the opinion that such a course must contain thorough drill in the fundamental principles of both chemistry and electricity, and a full treatment of the borderland between the two sciences, which is the special province of electro-chemistry as a pure science. This end is best attained by starting with the course in metallurgy and modifying it so as to include the fundamentals of electrical engineering, and adding thereto lectures and laboratory work in specific electro-chemical subjects. It is probable that a course thus constructed will be found not only to meet the practical needs of the student wishing to enter the electro-chemical industries, but also that it will possess a high educational value.

The Pentachloride, Pentabromide, and Pentaiodide of Antimony and their Double Salts.—A. Rosenheim and W. Stellman.—Pentachloride of antimony in solution in absolute alcohol when treated with hydrochlorate of pyridine, cooled down to 0°, and then treated with gaseous hydrochloric acid, gives beautiful reddish brown needles of chlorantimoniate of pyridine, $3C_5H_5NHCl.2SbCl_5$; in the same manner we can obtain the corresponding compounds of quinolein and dimethylaniline, in beautiful white crystals. The pentabromide of antimony, $SbBr_5$, has not yet been isolated, but if ether is cooled and kept in the dark and saturated with HBr gas, then treated with antimonic acid, a brown solution is formed which, if treated with bromhydrate of pyridine in alcoholic solution, gives black crystalline flakes of a bromantimoniate, $2C_5H_5NHBr.SbBr_5$; these can only be re-crystallised by adding an excess of bromine and re-cooling, otherwise we obtain yellow needles of a bromantimonite, $2C_5H_5NHBr.SbBr_3$. Analogous results are obtained with quinolein, &c. Antimonic bromide combines with a very large number of organic substances; we operate in the presence of chloroform, which enables us to obtain the products unchanged in a crystalline form; with aldehyde we obtain $SbCl_5.C_2H_4O$, in yellowish white needles; with benzylic aldehyde $SbCl_5.C_6H_5COH$, in needles; with acetone $SbCl_5.CH_3COCH$, in prisms; with chloride of benzoyl $2SbCl_5.3C_6H_5COCl$, in needles; with benzoate of ethyl $SbCl_5.C_6H_5CO_2C_2H_5$, in rhombic tables; acetamide gives $2SbCl_5.3CH_3CONH_2$; phthalic anhydride $2SbCl_5.3(CH_4[CO]_2O)$; with oxalic acid we get $2SbCl_5.C_2O_4H_2$ in prisms. It is necessary to take 2 molecules of $SbCl_5$; with only one we should get a different reaction. Succinic acid gives $2SbCl_5.C_4H_6O_4$ in fine needles, and nitrobenzene gives $2SbCl_5.3C_6H_5NO_2$. The carbides do not unite with $SbCl_5$ without alteration; with benzene there is a reduction to the state of trichloride and the formation of $3SbCl_3.C_6H_5$, in large prisms.—*Ber.*, xxxiv., 3377.

Royal Institution.—A General Monthly Meeting of the Members of the Royal Institution was held on the 2nd inst., Sir James Crichton-Brown, Treasurer and Vice-President, in the Chair. The following were elected Members:—Dr. Louisa Garrett Anderson, Dr. Henry T. Böttinger, Mr. W. Child, Mrs. Ionides, Miss E. Lee-Smith, Sir Frederick Treves, Bart., and Mr. W. Whitehead.

Institute of Chemistry of Great Britain and Ireland.—Pass List of the January Examinations.—Of twelve candidates who entered for the Intermediate Examination, the following eight passed:—D. B. Byles, B. F. Davis, A. V. Elsden, James Gray, Arthur Hopwood, J. R. Johnson, W. O. Littlebury, and H. Stevenson. In the Final Examination for the Associateship (A.I.C.) in Mineral Chemistry, of eight who entered the following six passed: K. B. Benham, A. E. Case, B.Sc., G. F. D. Green, T. B. Kirkhope, M. W. Stevens, Assoc.R.C.Sc., and James Thorburn; one candidate passed in Physical Chemistry: J. Johnston; in Organic Chemistry, of the eleven who entered the following seven passed: H. W. Bywaters, Assoc.R.C.Sc., Ph.D., H. Finnemore, R. J. Hall, B.Sc., F. T. Jewson, S. G. Paine, J. B. Puraglove, and H. A. Tempany, B.Sc.; of six who entered in the branch of the Analysis of Food and Drugs, and of Water, including the examinations in Therapeutics, Pharmacology, and Microscopy, the following five passed: W. L. St. J. Alton, J. C. Gregory, B.Sc., E. K. Hanson, B.A., F. E. King, B.Sc., and A. W. Knapp, B.Sc. The Examiners in Chemistry were Dr. Bernard Dyer and Professor W. Palmer Wynne; Dr. Arthur P. Luff conducted the examination in Therapeutics, Pharmacology, and Microscopy.

MEETINGS FOR THE WEEK.

Monday, 9th.—Society of Arts, 8. (Cantor Lectures). "Paper Manufacture," by Julius Hübner.

Tuesday, 10th.—Royal Institution, 5. "The Physiology of Digestion," by Prof. Allan Macfadyen, M.D.

—— Society of Arts, 5. "Women in Canada," by the Countess of Aberdeen.

Wednesday, 11th.—Society of Arts, 8. "The Port of London," by B. W. Ginsburg, M.A., LL.D.

Thursday, 12th.—Royal Institution, 5. "Arctic and Antarctic Exploration," by Sir Clements Markham, K.C.B., F.R.S.

Friday, 13th.—Royal Institution, 9. "Health Dangers in Food," by Prof. Sheridan Delépine, M.B., B.Sc.

—— Physical 5. Annual General Meeting. Address by President elect.

Saturday, 14th.—Royal Institution, 3. "Dramatic Criticism," by Arthur B. Walkley.

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JOURNAL OF PHYSICAL SCIENCE

Edited by Sir Wm Crookes, F.R.S.] (WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE") [Established Fifty-eight Years.

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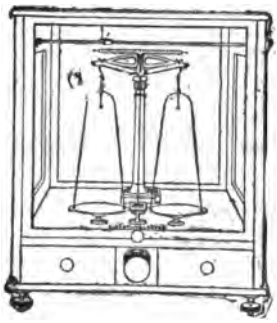

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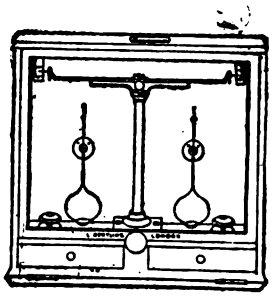

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THE CHEMICAL NEWS.

Vol. LXXXVII., No. 2255.

REVISION OF THE ATOMIC WEIGHT OF LANTHANUM.*

By BOHUSLAV BRAUNER, Ph.D., and FRANTIŠEK PAVLÍČEK, Bohemian University, Prague.

(Continued from p. 64).

Second Method of Atomic Weight Determination. Analyses of Lanthanum Sulphate. New Hydrate of Lanthanum Sulphate.

Conversion of the anhydrous sulphate into the oxide by calcination was the method used by Marignac, in 1873, who obtained in this way La = 138·81 (see Table I.), and the same method was used later on with scandium, thorium, and cerium (Nilson, Krüss, Brauner).

The residues from the above two series of experiments were purified from alkali, &c., in the manner already indicated, and the anhydrous sulphate of lanthanum was prepared. It was dissolved in five to six parts of ice-cold water in a platinum dish plunged in ice, but instead of crystallisation being effected by heating to 35—40° (Mosander, Bunsen), the ice-cold solution was stirred until the hydrated salt had separated out, after which it was allowed to assume the ordinary temperature.

The salt was collected by suction on a perforated platinum plate, washed well with cold water, and dehydrated at 500—600°. By repeating this process of recrystallisation ten times, the fractions P 1 to P 10 were obtained from the original sulphate P.

During these experiments, in which I was aided by Mr. Picek, we observed that the proportion of the sulphate remaining in the filtrates was not always the same, and, similarly, the character of the sulphate was different. The sulphates P 4, P 6, P 7, and P 10 consisted of fine needles, others formed distinct prismatic crystals resembling the enneahydrate.

The salt P 4 was especially characteristic as forming flocks like alumina, consisting, however, of the finest needles. It separated out at 0—1°; it was quickly collected on the pump, pressed between smooth paper, and the dry powder immediately weighed in a closed platinum crucible.

Experiment 28.—1·93822 grms. of the salt P 4 gave, on drying at 500°, a residue of 1·28710 grms. and on further drying for eight hours at 550° ±, of 1·28663 grms. of the anhydrous salt, from which it is seen that lanthanum sulphate parts only with great difficulty with the last traces of its water of crystallisation. The loss of weight, which in this case can only be due to loss of water, was 0·65159 grm., or 33·618 per cent, which is equivalent to 15·92 molecules.

The remaining 1·28663 grms. of the anhydrous sulphate were very gradually heated to a yellow heat, and yielded 0·74122 grm. of La_2O_3 = 57·6103 per cent. From this, La = 139·207.

In order to ascertain whether the weight of the oxide remained constant, the product was heated again for one hour over the blowpipe. Its weight became 0·74153 grm.; that is, it became heavier by 0·0003 grm. On further heating, the weight decreased to the minimum of 0·74123 grm. (compare Experiment 29).

It is evident from the above that the hydrated salt analysed is a new hydrate of lanthanum sulphate, the *hekkaidekahydrate.*

		Calculated.		Found.
La_2O_3	.. =	326·17 (*a*)	38·17	38·24
$3SO_3$	.. =	240·18	28·10	28·14
$16H_2O$	.. =	288·24	33·73	33·62
		854·59	100·00	100·00

(*a*) The atomic weight "in air" is used here.

Muthmann and Rölig (*Ber.*, 1893, xxxi., 1723) say that the enneahydrate ($+9H_2O$) is formed at all temperatures, and that they endeavoured in vain to obtain another hydrate, so that the existence of the new hydrate is not devoid of interest. (The hexahydrate crystallises only from an acid solution).

Mr. Picek tried to determine the solubility of the hekkaidekahydrate and its transition temperature into the enneahydrate, but we only learned that the system, hekkaidehydrate + water, is a very labile one, even at a temperature near 0°.

For a second experiment, the salt P 10 was used. It undoubtedly originally consisted chiefly of the hekkaidekahydrate; it was well drained on the pump and kept in a covered platinum dish. Next day it was found to be very moist and converted completely into the enneahydrate.

Experiment 29.—1·96466 grms. of the air-dried salt gave 1·51969 grms. after heating for ten hours at 530°, and, after further drying for six-and a-half hours at 600° ±, 1·51947 grms., showing that the last 0·00022 grm. of water was retained very strongly. The loss of weight, 0·44519 grm., amounts to 22·66 per cent, the calculated amount for $9H_2O$ being 22·26 per cent.

On raising the temperature gradually to the highest yellow heat obtainable with the blowpipe, this salt was found to lose its sulphuric acid with great difficulty, and all attempts to obtain an oxide of a constant weight were fruitless:—

Time of heating.	Weight of residue in grm.	Apparent atomic weight of La.
Half-day over the blowpipe ..	0·95751	180·6
Half-day ,, ,, ..	0·87937	140·9
One day ,, ,, ..	0·87521	139·192
Eight and a-half hours over the blowpipe	0·87649	139·70
Ten minutes at yellow heat ..	0·87586	139·43
Two hours over the blowpipe ..	0·87645	139·68
Quarter hour at almost white heat	0·87571	139·36

In the last instance, the temperature was so high that the two crucibles were nearly soldered together.

It is seen from Experiments 28 and 29 that the above simple method, which gives excellent results with such weak bases as CeO_2 and ThO_2, cannot be used with the strong base La_2O_3. But even when the minimum weight was reached by a chance, the oxide was heavier by 0·00012 grm. than required by theory. T. W. Richards has found that oxides obtained from the sulphates "occlude" a larger quantity of gases than those obtained by heating the oxalates. Lanthanum oxide obtained from the oxalate is voluminous and almost white, that obtained from the sulphate is denser and greyish-buff in colour.

The fact that after ten re-crystallisations from its aqueous solution the sulphate is perfectly normal and not even slightly basic, shows that the amount of its hydrolysis in a cold aqueous solution of the above concentration must be quite inappreciable.

Experiment 30.—This shows that on heating lanthanum sulphate to the highest temperature obtainable with a Bunsen burner (without blast) it loses easily two-thirds of its SO_3, and a new basic sulphate La_2O_3,SO_3, stable at a higher temperature, is obtained.

4·0867 grms. of the anhydrous sulphate, obtained by synthesis from 2·3535 grms. of the oxide, yielded, when heated as above, a residue weighing 3·2044 grms., which when heated to a still higher temperature decreased to

* From the *Transactions of the Chemical Society*, 1902, vol. lxxxi.

2·9146 grms. of the basic sulphate. From this, SO_3 = 0·5611 grm., an amount approaching that required for $1SO_3$ = 0·5777 grm. An analogous phenomenon was observed by me in the case of praseodym sulphate.*

The above two experiments show that the true atomic weight of lanthanum cannot lie higher than 139·20 (in air) or 139·14 (in a vacuum). No indication of a "lanthanum" with the low atomic weight 135 was found in our purest lanthanum material.

(To be continued).

THE METALLIC NATURE OF HYDROGEN.

By GEOFFREY MARTIN, B.Sc.(Lond.).

One of the most remarkable facts in chemistry is the two-fold nature of hydrogen. On the one hand, it behaves precisely as a metal in a vast number of its chemical relations; and on the other hand, it exhibits equally decided non-metallic characteristics.

Its metallic properties are striking in the extreme:—

1. It generates a whole series of salts—the so-called acids—which are perfectly analogous to the corresponding compounds of Na and K, except in so far as they are stamped with the peculiarities of hydrogen itself. Such compounds, for example, are capable of electrolytic dissociation, the H playing precisely the same part as a Na or K ion.

It was such facts as these, as well as the other special chemical relations of combined H, that forced the great chemists of the preceding century—Faraday, Dumas, Daniell, Graham, and Andrews—to entertain the view that H was metallic in nature, and allied to K or Na.

2. When hydrogen enters into the structure of a compound it exercises the same effect on its properties as a light metal, such as Na or K, making in general an acid compound less acid, and a basic compound more basic.

For example, phenol, $C_6H_5.OH$, is more acid in nature than hexylic alcohol, $C_6H_{13}.OH$; and benzoic acid, $C_6H_5.COOH$, is more acid than hexylic acid, $C_6H_{13}.COOH$.

Similarly, N_2H is an acid, but N_2H_4 and NH_3 are strong bases.

The same effect is produced by Na or K. For instance, H.OH is neutral, but H.ONa a strong base. The diminution of acidity which follows the replacement of H by Na is well seen in the malonic esters:—HOOC—CH_2—COOH, HOOC—CHNa—COOH, HOOC—CNa_2—COOH.

3. When the elements are arranged in the order of their affinity for positive electricity (Nernst, Newman), H actually occurs among the metals, between lead and tin, as the following series shows:—Mg, Al, Zn, Cd, Fe, Co, Ni, Pb, H, Sn, Cu, Hg, Pd, Au (Newman, *Zeit. f. Phys. Chem.*, 1894, xiv., 193, particularly pp. 222—223; *vide* also Nernst, *Ber.*, 1897, xxx., 2, 1547).

So that H is able to precipitate from their solutions such metals as Cu, Hg, Ag, Pt, Au_4 in just the same way that Mg precipitates such metals as Zn or Cd.

This may be easily shown experimentally by immersing a small plate of Pd, saturated with H, in a solution of $CuSO_4$. The plate soon becomes covered with a lustrous layer of Cu (Lüpke's "Electro-chemistry," 1897, p. 166).

4. Moreover, the thermal effects produced by the combination of H with equivalent quantities of the successive elements P, C, S, N, O are in the same order as those produced by the combination of Na with the same substances. Whereas the order in the case of a non-metal, such as chlorine, is diametrically opposite (van't Hoff "Lectures," iii., 93).

5. In addition, Pd is able to absorb several hundred times its volume of H gas and still retain its lustre and general metallic appearance, as would be the case if the compound is a Pd-H alloy.

From these facts it will be seen that H in its chemical relations presents all the characteristics of a metal.

On the other hand, Dewar has shown that liquid hydrogen is quite non-metallic in nature, being a non-conducting, transparent, mobile liquid, resembling, in fact, a liquid hydrocarbon rather than a metal.

How then are we to reconcile this sharp contrast between the chemical and physical nature of H?

For it is indisputable that H at ordinary temperatures behaves as a metal in most of its chemical relations.

While it is equally indisputable that at a very low temperature, at its boiling-point for example, hydrogen possesses the properties of a non-metal.

Is not the solution of this riddle to be sought in my suggestion (Chemical News, 1902, lxxxvi., 295) that a high temperature tends to bring out metallic properties, and conversely, a low temperature to bring out non-metallic properties, so that, although at ordinary temperatures and pressures H shows a marked inclination to exhibit the fundamental properties of a metal, yet, nevertheless, at −252·5° (its boiling-point) its metallic properties have entirely disappeared?

The idea is well worthy of consideration, inasmuch as it affords a very simple explanation of one of the otherwise most inexplicable facts in chemistry.

University of Kiel, January 22, 1903.

ACTION OF HYDROCHLORIC ACID ON THE SULPHATES OF THE SESQUIOXIDES OF ALUMINIUM, CHROMIUM, AND IRON.

By A. RECOURA.

When the salts of the sesquioxides of aluminium, chromium, and iron are dissolved in water they undergo a partial decomposition, especially when heated, and this has the effect of liberating a portion of the acid of the salt. On the other hand, it is probable from what we know of these compounds that the three hydroxyls of the bases, $Al(OH)_3$, $Cr(OH)_3$, and $Fe(OH)_3$, are not identical, and that some of them are able to change their functions under certain circumstances, as M. Wyrouboff has shown very plainly in his paper on the "Constitution of the Compounds of Chromium" (*Bull. Soc. Chim.*, Series 3, vol. xxvii., p. 666).

Under these circumstances it became interesting to try how the solutions of these salts would behave when acted on with a different acid to that in the salt, and one of less energy. Thus, for example, the sulphate of sesquioxide of chromium dissolved, losing, as I have already shown, under the action of heat, a portion of its sulphuric acid, which is set free; it was probable that if this decomposition took place in the presence of another acid more feeble than sulphuric acid, such as hydrochloric acid, for example, used in considerable excess, the base or the hydroxyls of the base liberated by the separation of the sulphuric acid, might fix one or more molecules of hydrochloric acid, and thus give rise to the formation of a polyacid salt in which the hydroxyls of the base would become saturated, some with the sulphuric acid, and the others with the hydrochloric acid.

Experiment has verified these suppositions. I am now about to give the results I have obtained by acting in hot solution with hydrochloric acid on the sulphates of aluminium, chromium, and iron.

With the sulphates of aluminium and chromium I obtained, as I expected, polyacid salts, $Al.SO_4.Cl.6H_2O$ and $Cr.SO_4.Cl.6H_2O$, while with sulphate of iron I transformed this sulphate, $Fe_2,3SO_4$, into an acid sulphate, $Fe_2,3SO_4.SO_4H_2.8H_2O$.

I will describe first the chromic compound, which has very interesting properties.

* This fact was communicated to the Chemical Society on Feb. 24, 1902. Later on (*Comptes Rendus*, 1902, cxxxiv., 657), basic sulphates of Pr and Nd of the same formula, R_2O_3,SO_3, were described by Matignon. My discovery was made independently of that author.

Chlorosulphate of Chromium, $Cr.SO_4.Cl.6H_2O$.—This compound is obtained easily in the following manner:—To 50 c.c. of fuming hydrochloric acid brought to the boiling-point, we add 60 grms. of the violet sulphate of chromium, which dissolves immediately, giving a green liquid. Boil for a quarter of an hour, and let the solution stand. After the lapse of several days a mass of crystals is formed, which is drained as thoroughly as possible, and then washed with a mixture of alcohol and acetone. Thus we obtain a green powder very soluble in water, and to which analysis gives the formula $Cr.SO_4.Cl,6H_2O$. (Found—Cr, 1; SO_4, 1·003; Cl, 1·001; H_2O, 5·95).

It should be remarked that in this compound we find the 6 molecules of water that exist in the two chlorides of chromium, the green chloride and the violet chloride, which have both the composition $CrCl_3\,6H_2O$. These 6 molecules of water are water of constitution, as I shall show further on; the loss of a single one of these molecules modifies the properties of the body considerably. It should be remembered that while the green chloride of chromium is soluble in alcohol and in acetone, this compound is insoluble therein. I would add that we must give it the molecular formula $CrSO_4Cl$, and not a double or triple formula, since this is required by the cryoscopic measurements given later on.

The most interesting property of this body is the following:—The chlorine it contains is not precipitated by nitrate of silver, while the whole of the sulphuric acid is precipitated immediately by chloride of barium. The experiment should be made in the following manner:—To a dilute solution (1 molecule to about 35 litres) freshly made, cooled to 0°, and acidulated with nitric acid, we add the equivalent quantity of nitrate of silver. The solution remains perfectly limpid for more than a quarter of an hour, then it becomes cloudy, and gradually a precipitate is formed. If we operate at the ordinary temperature and without the addition of nitric acid the precipitation commences almost immediately. For, like all the complex compounds of chromium that I have described, and in which the acid radicles are masked, this one is transformed fairly rapidly by water. Thus, after a certain time, the solution of this body, which is green at first, changes to violet, and it is then no longer anything more than a *mixture* of the violet chloride and the violet sulphate; this can be verified easily by cryoscopy.

A recently made solution, containing 3·564 grms. of chlorosulphate of chromium in 100 grms. of water, congeals at −0·29°. The same solution kept for six days, and become violet, congealed at −0·42°. Now, the corresponding quantities of the violet sulphate and the violet chloride produce, at the same dilution, lowerings of temperature which are respectively 0·16° and 0·26°, and of which the sum is 0·42°. Thus, it is seen easily that the solution of the chlorosulphate of chromium, after it has become violet, is nothing but a mixture of the sulphate and the chloride.

Chlorosulphate of Chromium, $Cr.SO_4.Cl,5H_2O$.—The preceding salt, which contains 6 molecules of water when kept at a temperature of 85°, gradually loses water, and we observe that when it has lost 1 molecule, its solution, when very dilute (1 molecule in 500 litres), which previously was precipitated by chloride of barium, no longer has that property, all other conditions being the same. Neither is it precipitated by nitrate of silver. Thus the loss of 1 molecule of water has the effect of making the sulphuric acid enter the complex radicle which already contains the chlorine and the chromium. If we continue to heat it, still at 85°, this compound continues to lose water and becomes more difficultly soluble, but at the same time it loses a little hydrochloric acid.

It became of interest to determine the lowering of the congelation point of the aqueous solutions of this compound. We know, as a matter of fact, that while the molecular lowering in water of non-electrolytic compounds is 18·5, electrolytes always have a much more pronounced molecular lowering, which is generally explained by their partial dissociation into their ions, caused by the water, and this has the effect of increasing the number of active cryoscopic particles. Now, the compound in question does not undergo double decomposition, so it may be presumed that it is not dissociated by water, and that it will behave like the non-electrolytes. This has been fully verified by experiment. I have found for the molecular lowering of the compound $Cr.SO_4.Cl,5H_2O$ the number 18·8; that is to say, the same lowering as the non-electrolyte; while under the same conditions of dilution (1 molecule per 10 litres) the compound with 6 molecules of water, which is dissociable, gave 23·7, and the green chloride of chromium, $CrCl_3.6H_2O$, gave 40.

It must be observed that the compound with 5 molecules of water is transformed very rapidly when it is dissolved into the compound with 6 molecules of which the sulphuric acid is precipitable. Thus, after twenty minutes solution, the molecular lowering is already brought up from 18·8 to 21·1, and the solution is precipitated perfectly by chloride of barium. But if the dehydration is pushed beyond the $5H_2O$ stage,—if, for example, the compound is made to give up 2 molecules of water,—its solution is then much more stable; the sulphuric acid is masked for a much longer period.

I shall return later on to the constitution of these compounds, and that will help to fix that of the other complex compounds of chromium, which is occupying the attention of many chemists at the present time.

Chlorosulphate of Aluminium, $Al.SO_4.Cl,6H_2O$.—This compound is prepared under the same conditions as the chromic compound. To 50 c.c. of boiling fuming hydrochloric acid we add 40 grms. of sulphate of aluminium, which dissolves immediately. Boil for a quarter of an hour; on cooling, the liquor gives an abundant crop of crystals, which are drained and then re-crystallised a second time, under the same conditions, by dissolving them in boiling hydrochloric acid. The crystals are drained carefully and then washed with acetone.

In this manner we obtain a salt which is very soluble in water, and almost insoluble in alcohol, of the composition $Al.SO_4.Cl,6H_2O$. (Found—Al, 1; SO_4, 0·999; Cl, 1·002; H_2O, 5·9).

It should be remarked that we find in this compound the 6 molecules of water that are present in chloride of aluminium, $AlCl_3,6H_2O$, in the same manner that we find the 6 molecules of water of the chromic chloride in the corresponding compound of chromium.

We may ask if the compound thus obtained is really a polyacid salt, $AlSO_4Cl$, or if it may not be a double salt, $Al_2,3SO_4.AlCl_3$, resulting from the union of a molecule of sulphate of aluminium with a molecule of the chloride. In the case of the chromic compound the properties of the body, as well as the cryoscopic measurements, leave no doubt in this respect, as has been seen.

They show that the aqueous solution of this body really contains the compound $CrSO_4Cl$ from the commencement, but being unstable this compound is gradually destroyed by the water, and that after the lapse of several days it contains nothing but a simple mixture, $Cr_23SO_4 + CrCl_3$.

In the case of the aluminic compound the cryoscopic measurements show that the solution in water, even from the first minute, is nothing more than a simple mixture of sulphate of aluminium and the chloride. In fact, the lowering of the congealing point of the aqueous solution of this compound is the sum of the lowering of the congelation points of the sulphate and the chloride it contains.* Thus, while the chlorosulphate of chromium is only destroyed slowly by water, that of aluminium is decomposed at the moment of its solution; consequently, the

* In fact, a solution containing 1 grm. of the compound in 100 grms. of water congeals at −0·50°. Now, the amounts of sulphate and of chloride they contain, produce, at the same dilution, lowerings which are respectively 0·22° and 0·30°, and the sum is 0·52°. Thus we see plainly that the solution of chlorosulphate of aluminium behaves as a mixture of the sulphate and the chloride.

examination of the solution does not enable us to solve the question of the composition of the solid compound.

But admitting that it is produced under exactly the same conditions as the chromic compound, and that it has exactly the same composition, we are justified in assuming that it has probably the same constitution; that is to say, that it is a polyacid.

Further, this opinion is confirmed by the following fact:—If the compound was a double salt we should probably obtain it by crystallising a mixture of the sulphate and the chloride dissolved in water. Now, in the crystallisation of such a mixture there is no trace of the chlorosulphate of aluminium formed; the crystals obtained are a mixture, in variable proportion, of sulphate and chloride, a mixture which, when treated with alcohol, gives up the whole of its chloride, while the chlorosulphate is undecomposed by alcohol under the same conditions.

For all these reasons we must admit that the chlorosulphate of aluminium, $Al.SO_4.Cl,6H_2O$, has the same constitution as the chlorosulphate of chromium, $Cr.SO_4Cl,6H_2O$. Now, I have shown that this body is a complex compound, that the chlorine is masked, and that in the same compound with 5 molecules of water the sulphuric acid also is masked. Therefore it is probable that the same is the case with the aluminic compound. But while we are able to prove it with the chromic compound because it is only decomposed slowly by water, we cannot do the same with the aluminic compound, since it is instantly decomposed by water.

This is the same with the whole series of complex compounds of chromium that I have examined. We can prove their properties, since, though fragile, solution in water does not destroy them immediately. It is not improbable that analogous compounds of aluminium exist; but it is probable that these compounds, like the chlorosulphate of aluminium, are destroyed very rapidly on solution.

Acid Ferric Sulphate, $Fe_2,3SO_4.SO_4H_2,8H_2O$.—We might expect ferric sulphate to form an analogous compound, but such is not the case. Under the same conditions ferric sulphate forms, not a chlorosulphate, but on the one hand ferric chloride, and on the other hand an acid sulphate, $Fe_2,3SO_4,SO_4H_2,8H_2O$. I am engaged with its examination at the present time, and will publish the results before long.

I am also making an examination of the action of the different acids on the salts of aluminium, chromium, and iron.—*Bull. Soc. Chim.*, Series 3, vol. xxvii., No. 23.

THE DOUBLE AMMONIUM PHOSPHATES IN ANALYSIS.*

By MARTHA AUSTIN.

The function of ammonium salts in the formation of double ammonium phosphates for the purposes of analysis has been the subject of a good deal of study. Manganese, which tends to fall as the tribasic phosphate, $Mn_3P_2O_8$ (Gooch and Austin, *Am. Journ. Sci.*, vi., 233) appears in the presence of a sufficiency of ammonium salt in the form of the ammonium manganese phosphate, $(NH_4)MnPO_4$, which gives the pyrophosphate, $Mn_2P_2O_7$, on ignition. Magnesium (Gooch and Austin, *Am. Journ. Sci.*, vii., 187; Neubauer, *Zeit. Anorg. Chem.*, ii., 45—50; iv., 251—266; x., 60—65; *Zeit. Angew. Chem.*, 1896, 435—440; *Journ. Am. Chem. Soc.*, xvi., 289), on the other hand, tends to pass under the influence of ammonium salt toward the condition of the diammonium magnesium phosphate which yields the metaphosphate on ignition. Further, in the cases of zinc and cadmium (Austin, *Am. Journ. Sci.*, viii., 206) it has been my experience that the presence of a considerable amount of ammonium salt is essential to the precipitation of the ideal double ammonium phosphates of both these elements, although, in the case of cadmium, too large an amount of the ammonium salt prevents complete precipitation and apparently occasions the formation of a phosphate too rich in ammonia. The solvent effect of the reagents in the case of mercury phosphate (Austin, *Am. Journ. Sci.*, viii., 206) is very great, yielding a new salt the composition of which has not been investigated in recent years. Beryllium (Roessler, *Zeit. Anal. Chem.*, xvii., 148) is only partly converted to that ammonium beryllium phosphate which yields the pyrophosphate on ignition, even in the presence of large amounts of ammonia salt. Neither an ammonium salt nor ammonia in solution converts the phosphates of barium, strontium, and calcium (Austin, *Am. Journ. Sci.*, viii., 206) to the double ammonium phosphates. Of these three elements barium alone falls in the form of the hydrogen barium orthophosphate. In certain recent articles upon the precipitation of the double ammonium phosphates some of the facts mentioned above have been called in question.

In the determination of zinc and manganese Dakin (Chemical News, lxxxii., 101; lxxxiii., 37) has proposed to substitute ammonium phosphate as the precipitant in place of microcosmic salt (hydrogen ammonium sodium phosphate) in presence of a considerable amount of ammonium chloride, and to wash with a 1 per cent solution of the precipitant followed by alcohol. Dakin's analytical results, taken without scrutiny, would seem to show that the precipitate produced by ammonium phosphate (in only moderate excess), and washed with a 1 per cent solution of the precipitant and alcohol, has the ideal constitution of the double phosphate and leaves upon ignition the pyrophosphate.

From the standpoint of theory it is difficult to see why the ammonium phosphate should be more effective in producing the normal ammonium double salt than is hydrogen ammonium sodium phosphate in amount sufficient to supply the ammonium equivalent, or than a mixture of the equivalent amount of any soluble phosphate in association with enough ammonium salt to supply the same amount of the ammonium radical or ion. Whether the conversion of the tribasic phosphate of the type $R_3P_2O_8$ to the double ammonium phosphate of the type $(NH_4)RPO_4$ be viewed either as dependent upon the interaction according to mass of reagents assembled, or from the point of view of the ion theory (Gooch and Austin, *Am. Journ. Sci.*, vi., 233; Boettger, *Ber. Chem. Gesell.*, xxxiii., 1019), the action of a solution of ammonium phosphate should not differ much from that of equivalent amounts of other ammonium salt and soluble phosphate. My own experience with the double ammonium zinc phosphate confirms this view (*Am. Journ. Sci.*, viii., 210). In the accompanying table are reproduced from my former paper the data of certain experiments bearing upon this point. (See next page).

The results of the experiments of Section B, in which the precipitation was made by microcosmic salt in presence of a small amount of ammonium chloride, show an average constitution of the precipitate similar to that of the precipitate obtained in A by an equivalent amount of ammonium phosphate; but the results of both series, A and B, vary considerably from the ideal much more closely approximated in the experiments of C, in which precipitation was made in the presence of a large excess of ammonium chloride. With these results those of Dakin are not in accord. Upon examination, however, Dakin's procedure appears to be open to criticism.

In the first place, it appears that the asbestos employed by Dakin was of the hydrous (serpentine) variety, which disintegrates when heated and is readily acted on by many reagents. Though previously treated with hydrochloric acid, it was, by Dakin's account, perceptibly soluble in a solution of ammonium phosphate. After

* Contributions from the Kent Chemical Laboratory of Yale University. From the *American Journal of Science*, vol. xiv., No. 80.

	$Zn_2P_2O_7$ corresponding to $ZnSO_4$. Taken. Grm.	Found. Grm.	Error in terms of $Zn_2P_2O_7$. Grm.	Error in terms of zinc. Grm.	Zinc left in the filtrate.	$(NH_4)_2PO_4$. Grms.	NH_4Cl. Grms.	Time of standing. Hours.
				A.				
1.	0·6355	0·6206	0·0149−	0·0060−	Trace	3·13	—	1½
2.	0·6355	0·6254	0·0101−	0·0040−	,,	3·13	—	16
3.	0·6355	0·6300	0·0055−	0·0022−	,,	3·13	—	16
				B.				
						$HNaNH_4PO_4.4H_2O$.		
4.	0·6355	0·6271	0·0084−	0·0034−	Trace	4·47	0·5	1
5.	0·6355	0·6256	0·0099−	0·0040−	None	4·47	0 5	20
				C.				
9.	0·6355	0·6335	0·0020−	0·0008−	None	4·47	10	16
10.	0·6355	0 6381	0·0026+	0·0010+	,,	4·47	20	½
11.	0·6355	0·6379	0·0024+	0·0009+	,,	4·47	20	2
12.	0·6355	0 6386	0·0031+	0·0012+	,,	4·47	20	½
13.	0·6355	0·6393	0·0038+	0·0014+	,,	4·47	20	½
14.	0·6367	0·6355	0·0012+	0·0005+	,,	4·47	30	16

drying at 100°—105° the crucible and felt lost some decimilligrms. on ignition. It was on this account that Dakin weighed precipitate and filter, after drying at 100°—105°, when the double phosphate was to be estimated as such, or after ignition when the zinc pyrophosphate was weighed, and then, dissolving the precipitate in nitric acid, re-weighed the crucible and asbestos, and by difference from the former weight obtained the apparent weight of the precipitate. The inevitable loss through disintegration or solubility of the filter in the nitric acid used to dissolve the precipitate in Dakin's procedure, must raise the corresponding apparent weight of the precipitate itself. Any series of results based upon the use of such material must of necessity be imperfect to the extent to which the ignited filter disintegrates or dissolves under the action of the nitric acid used to dissolve the precipitate.

Anhydrous (amphibole) asbestos, the material of which I made use, is insoluble, under the conditions of analytical work, in ordinary reagents, including even the strong acids, as has been abundantly shown (Gooch, *Am. Chem. Journ.*, i., 317; Mar, *Am. Journ. Sci.*, xii., 288; xliii., 521; Browning, *Am. Journ. Sci.*, xliv., 399; Phinney, *Am. Journ. Sci.*, xlv., 468). It is likewise completely insoluble in ammonium phosphate under the conditions of the work described, as I have found by experiment. Herein lies one cause of difference between Dakin's results and mine.

A second source of error in Dakin's procedure is found in the fact that precipitates of the double ammonium phosphates are washed in a 1 per cent solution of the reagent, ammonium phosphate followed by "re-distilled alcohol." Dakin calls attention to the fact that absolute alcohol must not be used, but makes no mention of the exact strength of the alcohol employed in his work.

In order to test the insolubility of ammonium phosphate in alcoholic washing I have made various experiments, the details of some of which are given in the following account. Portions of a solution of manganous chloride, standardised as the sulphate according to the method (*Am. Journ. Sci.*, v., 209) described in a former paper, were carefully measured from a burette, ammonium chloride and microcosmic salt were added in the proportions formerly recommended, and precipitation of the ammonium manganese phosphate was completed exactly as directed. After cooling, the precipitates were collected on asbestos under pressure in a perforated platinum crucible. In the experiments, the results of which are given under A of the table, the precipitate was in each case washed with distilled water made faintly ammoniacal, while in those recorded under B, C, and D of the table the precipitate was washed with 200 c.c. of a 1 per cent ammonium phosphate solution, and rinsed with 40 c.c. of alcohol of different strengths,—60, 80, and 88 per cent,—applied in successive portions.

	Grm.	Grm.
$Mn_2P_2O_7$ corresponding to $MnCl_2$ taken	0·3020	
A. Washed with ammoniacal water ..	0·3042	0·3020
B. Washed with 1 per cent $H(NH_4)_2PO_4$, rinsed with 60 per cent alcohol ..	0·3050	0·3041
C. Washed with 1 per cent $H(NH_4)_2PO_4$, rinsed with 80 per cent alcohol ..	0·3058	0·3074
D. Washed with 1 per cent $H(NH_4)_4PO_4$, rinsed with 88 per cent alcohol ..	0·3066	0·3086

From these experiments it appears that the procedure involving the washing of a precipitate of ammonium manganese phosphate by a 1 per cent solution of ammonium phosphate, draining with the pump, and then completing the washing with alcohol, results in a contamination of the precipitate proportionate to the strength of the alcohol used. Even the thin felt of asbestos alone when washed with ammonium phosphate followed by alcohol retains amounts of that salt proportionate to the strength of the alcohol employed. This is shown in the accompanying statement.

	Grm.
Weight of asbestos felt	0·0681
Weight of asbestos felt after washing ten times with a 1 per cent solution of ammonium phosphate and rinsing with distilled water	0·0681
Weight of asbestos felt after washing with a 1 per cent solution of ammonium phosphate and rinsing with alcohol of the strength given	0·0682 (60 per cent) 0·0684 (80 ,,) 0·0686 (88 ,,)

So it appears that in washing with ammonium phosphate and alcohol, according to Dakin's procedure, the precipitate of the double ammonium phosphate must be loaded with foreign material to a degree dependent upon the conditions. This error is in the same direction as that introduced by the solubility of the serpentine in nitric acid. With these two sources of error active, the most remarkable thing about Dakin's results is that they happen to agree so closely with mine, the solubility of the serpentine asbestos and the insolubility of the ammonium phosphate in alcohol together counterbalancing the deficiency due to imperfect constitution of the double ammonium phosphate.

As to the experience of Miller and Page (*School of Mines Quarterly*, xxii., 391) upon the ammonium cadmium phosphate, in consequence of which they concluded not only that my method for the estimation of cadmium is unsatisfactory, but that "asbestos filters should be avoided on account of the solvent action of either ammonium phosphate or nitric acid," it is sufficient to direct attention to the fact that their analytical examination of

this process is wholly worthless by reason of their use of serpentine asbestos.

With suitable anhydrous asbestos at disposal, the estimation of magnesium, manganese, cadmium, and zinc precipitated as the double ammonium phosphate, according to the directions, and with the precautions laid down in the former papers from this laboratory to which reference has been made, is perfectly practicable. Concerning the manganese and zinc phosphates, in particular, it may be reiterated that with a sufficiency of ammonium salt, preferably the chloride, and with an excess of the precipitant present, the precipitation is complete, and the phosphate formed of nearly ideal constitution. In the precipitation of the ammonium cadmium phosphate the proportions of the reagents must be regulated with care. The use of ammonium phosphate followed by rinsing in alcohol is not only wholly unnecessary but always altogether undesirable.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Wednesday, January 21st, 1903.

Prof. J. Emerson Reynolds, Sc.D., F.R.S., President, in the Chair.

Mr. W. H. Edwards was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. George Henry Appleyard, 151, Cleveland Street, Hull; Samuel Bradbury, Thornham New Road, Castleton; George Thomas Branch, Claremont, Cape Town, S. Africa; Hubert William Bywaters, 11, King Street, Regent Street, W.; William Henry Cadman, Lord Williams's Grammar School, Thame; John Castell-Evans, 141, Ferme Park Road, Crouch End, N.; Arthur John Codling, 5, Tavistock Square, W.C.; Benjamin Claxton Coyle, 65, Lansdowne Road, Dublin; Cecil Henry Desch, Instow, Mount Pleasant Road, Tottenham, N.; Leonard King Hindmarsh, 354, Lordship Lane, S E.; Franklin Wise Howorth, Rose Bank, Elmdale Road, Palmer's Green, N.; Arthur Graham Leigh, Chorcliff House, Chorley; Percy George Mander, Spon House, Spon End, Coventry; Frederick O'Brien, 15, Lilymead Avenue, Knowle, Bristol; Alec Bowring Steven, Ness House, Surbiton; George Malcolm Thomson, Newington, Dunedin, N.Z.; Stanley Tolson, 14, Furnivall Road, Balby, Doncaster; Francis Digby Toyne, Santubong, Sarawak; Thomas Crosbie Walsh, "Sunnyside," Muswell Avenue, Muswell Hill, N.; David John Williams, 1, St. Agnes Place, Kennington Park, S.E.

The Secretary announced that a communication had been received from Profs. Börnstein and Meyerhoffer stating that they were engaged in revising the *Physikalisch-chemische Tabellen* of Landolt and Börnstein, and would welcome from English chemists any suggestions of alterations or corrections for the new edition, addressed to them, "care of Verlag von Julius Springer, Berlin, N."

The Council has ordered the following report to be printed in the *Journal* and in the *Proceedings* of the Society:—

Report of the International Committee on Atomic Weights.

In the year 1900, an International Committee on atomic weights was organised, composed of more than fifty representatives from chemical and other societies. Its conferences were necessarily conducted by correspondence, and the delays and difficulties of the work proved to be both serious and annoying. Accordingly, the Committee, by vote, designated a smaller body of three representatives, and the latter now has the honour to report its recommendations.

On the fundamental question of standards, definite and formal action seems to be impracticable. By the original committee of the German Chemical Society, the oxygen standard was adopted, but that proposal, whilst receiving strong support, also met with serious opposition. In fact, opinion as expressed by individual voices seems to be somewhat evenly divided upon this question, and around it there has already grown up a controversial literature of formidable proportions. To force the adoption of either standard, oxygen or hydrogen, appears therefore to be impossible, and for some time to come both are likely to be employed. Between them, experience must be the final arbiter. That standard which best serves to co-ordinate chemical and physical knowledge will ultimately be chosen, and the other will gradually fall into disuse. Meanwhile, it is important that the most probable values for the several atomic weights should be indicated, and that every table of them should be consistent within itself. Such a table has been prepared by our distinguished predecessors, and its revision, as knowledge advances, seems to be our proper function.

In order that our work may be of the most general service, we have prepared a table in which both standards of atomic weight are represented. In most of its details it is identical with the table which was reported by the previous committee at the beginning of the year 1902 (in No. 1 of the *Berichte* for 1902). Some changes, however, have, in our judgment, become necessary, and these may be briefly indicated as follows:—

Antimony.—In the former reports of the commitee, the value derived by Cooke from analyses of the bromide, Sb = 120, was adopted. This, however, ignores the work of Cooke and of Schneider upon antimony trisulphide, and the still more recent determinations made by Friend and Smith. The true number being therefore in doubt, we recommend the use of an average value, and put Sb = 120·2 (O = 16).

Germanium.—The number 72·5 is more nearly in accord with Winkler's determinations than the former number 72.

Hydrogen.—In the column which represents the oxygen standard, hydrogen has heretofore been assigned the value 1·01. The number 1·008 is, however, much more exact, and the error in 1·01 is too large to be perpetuated. Each figure should be given to the nearest *significant* decimal.

Lanthanum.—During 1902, two new determinations of the atomic weight of lanthanum were published. According to Jones, La = 138·77. Brauner and Pavlicek found La = 139·04. Both investigations were conducted with great skill and care, and each one seems to have some points of advantage over the other. The average, La = 138·9, appears to be the safest value to adopt. These data naturally influence our judgment in the case of cerium, and we retain Brauner's number, Ce = 140, rather than adopt the lower estimates made by other observers.

Mercury.—Taking into account all the determinations which have appeared, and giving great weight to the most recent measurements by Hardin, we regard the value Hg = 200 as best warranted by the existing evidence.

Palladium.—The atomic weight of this metal is in doubt. The best determinations give values ranging from 106 to 107. The mean between them, Pd = 106·5, has been provisionally adopted.

Radium.—This element appears in the table for the first time. Madame Curie's determination of the atomic weight, Ra = 225, is probably not far from the truth.

Selenium.—Judging from the work of Lenher, and the very recent determinations by Jul. Meyer, the former value, Se = 79·1, is probably too low. In order to give due weight to the newer measurements, we write Se = 79·2.

Tin.—The determinations by Bongartz and Classen, which seem to be the best, make Sn = 119. The former value, 118·5, is almost certainly too low.

Uranium.—According to the very recent investigation

by Richards and Merigold, the atomic weight of uranium is 238·5.

Zirconium.—The figure Zr = 90·6 is apparently the most probable.

In thus assuming the duties assigned to us by the larger International Committee, we act upon the conviction that the purpose of our appointment is to secure the promptness and efficiency which is only possible with a comparatively small working body. In order to carry out this purpose, we must depend upon the co-operation and assistance of our colleagues. We therefore beg that they, and also all other chemists who are interested in researches upon atomic weights, will aid us with their criticisms and advice. We especially ask that publications upon the subject shall be sent to us, in triplicate if possible, so that no matter of importance may be overlooked. Without support of this kind our work cannot be made fully effective.

The complete table of atomic weights, with foregoing changes incorporated, follows.

F. W. Clarke
T. E. Thorpe } *Committee.*
Karl Seubert

International Atomic Weights. (1903).

		O=16.	H=1.
Aluminium	Al	27·1	26·9
Antimony	Sb	120·2	119·3
Argon	A	39·9	39·6
Arsenic	As	75·0	74·4
Barium	Ba	137·4	136·4
Bismuth	Bi	208·5	206·9
Boron	B	11	10·9
Bromine	Br	79·96	79·36
Cadmium	Cd	112·4	111·6
Cæsium	Cs	133	132
Calcium	Ca	40·1	39·8
Carbon	C	12·00	11·91
Cerium	Ce	140	139
Chlorine	Cl	35·45	35·18
Chromium	Cr	52·1	51·7
Cobalt	Co	59·0	58·56
Columbium (Niobium)	Cb	94	93·3
Copper	Cu	63·6	63·1
Erbium	E	166	164·8
Fluorine	F	19	18·9
Gadolinium	Gd	156	155
Gallium	Ga	70	69·5
Germanium	Ge	72·5	71·9
Glucinum (Beryllium)	Gl	9·1	9·03
Gold	Au	197·2	195·7
Helium	He	4	4
Hydrogen	H	1·008	1·000
Indium	In	114	113·1
Iodine	I	126·85	125·90
Iridium	Ir	193·0	191·5
Iron	Fe	55·9	55·5
Krypton	Kr	81·8	81·2
Lanthanum	La	138·9	137·9
Lead	Pb	206·9	205·35
Lithium	Li	7·03	6·98
Magnesium	Mg	24·36	24·18
Manganese	Mn	55·0	54·6
Mercury	Hg	200·0	198·5
Molybdenum	Mo	96·0	95·3
Neodymium	Nd	143·6	142·5
Neon	Ne	20	19·9
Nickel	Ni	58·7	58·3
Nitrogen	N	14·04	13·93
Osmium	Os	191	189·6
Oxygen	O	16·00	15·88
Palladium	Pd	106·5	105·7
Phosphorus	P	31·0	30·77
Platinum	Pt	194·8	193·3
Potassium	K	39·15	38·86
Praseodymium	Pr	140·5	139·4
Radium	Ra	225	223·3
Rhodium	Rh	103·0	102·2
Rubidium	Rb	85·4	84·8
Ruthenium	Ru	101·7	100·9
Samarium	Sm	150	148·9
Scandium	Sc	44·1	43·8
Selenium	Se	79·2	78·6
Silicon	Si	28·4	28·2
Silver	Ag	107·93	107·12
Sodium	Na	23·05	22·88
Strontium	Sr	87·6	86·94
Sulphur	S	32·06	31·83
Tantalum	Ta	183	181·6
Tellurium	Te	127·6	126·6
Terbium	Tb	160	158·8
Thallium	Tl	204·1	202·6
Thorium	Th	232·5	230·8
Thulium	Tm	171	169·7
Tin	Sn	119·0	118·1
Titanium	Ti	48·1	47·7
Tungsten	W	184·0	182·6
Uranium	U	238·5	236·7
Vanadium	V	51·2	50·8
Xenon	X	128	127
Ytterbium	Yb	173·0	171·7
Yttrium	Yt	89·0	88·3
Zinc	Zn	65·4	64·9
Zirconium	Zr	90·6	89·9

Of the following papers, those marked * were read:—

*1. "*Researches on Silicon Compounds.* Part VIII. *Interactions of Silicophenylamide with Thiocarbimide.*" By J. Emerson Reynolds.

The author has shown that the fine, crystalline silicophenylamide, $Si(NHC_6H_5)_4$, described in Part V. of this series of papers, loses aniline on careful heating, and affords, first, silicotriphenylguanidine and, subsequently, silicodiphenylimide (*Trans.*, 1900, lxxvii., 836).

The comparative ease and completeness with which the change $Si(NHPh)_4 = Si(NPh)_2 + 2NH_2Ph$ can be realised suggested another mode of producing the di-mide, involving the action of thiocarbimides. It was anticipated that silicophenylamide would react in the following manner: $Si(NHPh)_4 + 2R'N:CS = Si(NPh)_2 + 2CSN_2H_2PhR'$.

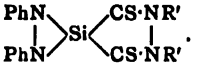
Whilst the above change can be realised, the author showed that the marked tendency of silicon to form complex molecules lead to other and unexpected interactions with thiocarbimides, and found that:—

1. Silicophenylamide in benzene solution is not decomposed by a thiocarbimide, even at the boiling-point of the solvent, but addition compounds are formed. For example, ethyl thiocarbimide in excess gives fine needle-like crystals consisting of $Si(NHPh)_4,2EtNCS$, and, when not in excess, rhombic plates of $Si(NHPh)_4,EtNCS$. Both compounds lose the whole of the thiocarbimide at 100°, and leave silicophenylamide unchanged.

2. A very different result is obtained when one molecule of silicophenylamide and two molecules of a thiocarbimide, without a solvent, are heated in sealed tubes at 160°. At first, the two compounds unite directly as before, but when the temperature rises to 140° a thick, slightly brown liquid begins to form, the production of which is complete on heating to 160° for half an hour. At the ordinary temperature, this substance is a very viscid liquid, and a specimen of the ethyl compound has been kept for several months without separation of any crystals. Methyl, ethyl, and phenyl thiocarbimides afford similar products, which have no odour of thiocarbimide, even when strongly heated; they are easily miscible with benzene, from which they are precipitated on addition of ligroin, and may thus be purified by a repetition of this treatment. Prolonged digestion of the benzene solution of each substance leads to a slow separation of silicodiphenylimide, whilst the liquid affords crystals of a di-substituted thiocarbamide. Therefore the interaction

anticipated actually does take place at a sufficiently high temperature, but the resulting silicon di-imide and thiocarbamide unite to form a homogeneous liquid consisting of $Si(NPh)_2,2CSN_2H_2PhR'$, which is slowly dissociated in boiling benzene.

3. Silicophenylamide also interacts with 4 molecules of thiocarbimides at 160°, but not with more than 4 molecules. The products are also viscid liquids at first, but they are not homogeneous, as crystals form to a relatively small extent in the mass on standing for some time, and are those of a substituted thiocarbamide. The liquid portion consists, in each case, of a new substance resulting from the action of the two additional molecules of thiocarbimide on the silicon di-imide produced in the first interaction. These liquids are miscible with benzene, but do not dissociate in it; they are decomposed by alcohol, and afford ethyl orthosilicate, alkyl dithiocarbamate, and a guanidine derivative, hence their constitution is probably—



Silicodiphenylimide, produced by heat from silicophenylamide, combines directly with thiocarbimides to form compounds of this type.

*2. "*On the Relation between the Absorption Spectra and the Chemical Structure of Corydaline, Berberine, and other Alkaloids.*" By J. J. Dobbie and A. Lauder.

It has been proved by purely chemical investigations that corydaline and berberine are closely related to one another, and that both alkaloids are constructed on the same general plan as papaverine, narcotine, hydrastine, and narceine.

An examination of the absorption spectra of the members of this group of alkaloids shows that those which are most closely related structurally give similar spectra, the differences in the spectra becoming more pronounced as the structural differences increase in importance. Thus corydaline and tetrahydroberberine closely resemble each other in structure, and the spectra of the latter only differ from those of the former in the somewhat greater general absorption which they exhibit. Narcotine only differs from hydrastine in containing an additional methoxyl group, and their spectra are almost identical, but quite distinct from those of corydaline, from which both differ considerably in structure. Papaverine and narceine are constitutionally still further removed from corydaline, and their spectra show a correspondingly increased difference as compared with those of the other members of the group. When papaverine, however, is reduced to tetrahydropapaverine, its constitution then corresponds much more closely with that of corydaline, and the spectra of the reduced compound are similar to those of corydaline.

When the corresponding derivatives of corydaline and tetrahydroberberine are compared, it is seen that the latter only differ from the former in possessing a slightly greater absorptive power. Since the only structural difference between the two series of derivatives consists in the replacement of two of the methoxyl radicles of corydaline by the dioxymethylene group in berberine, it was inferred that the difference in the amount of general absorption must be due to this difference of structure, and that the dioxymethylene complex must consequently exert a more powerful absorption than two methoxyl groups. The correctness of this inference received support from the direct comparison of the spectra of piperonylic acid, $C_6H_3(O_2CH_2)CO_2H$, with those of veratric acid, $C_6H_3(OMe)_2{\cdot}CO_2H$.

Whilst the spectra of ω-aminoethylpiperonylcarboxylic anhydride, $C_9H_7NO(O_2CH_2)$, from berberine, and of corydaline, $C_9H_7NO(OMe)_2$, from corydaline are very similar, they differ widely from those of cotarnine and hydrastinine, the corresponding oxidation products of narcotine and hydrastine respectively. This difference finds a sufficient explanation in the fact that the pyridine ring, which is closed in corydaline and ω-aminoethylpiperonylcarboxylic anhydride, is open in cotarnine and hydrastinine. The action of potassium hydroxide converts hydrastinine into oxyhydrastinine, in which the pyridine ring is closed. The spectra of oxyhydrastinine and corydaline are almost identical.

Hartley (*Phil. Trans.*, 1885, Part II., 471) has already shown that many of the alkaloids give highly characteristic spectra, and has pointed out the applicability of the method to the study of their constitution. The authors draw certain general conclusions as to the relation between the structure and the absorption spectra of the alkaloids. These conclusions are based chiefly on the results of the examination of the alkaloids of the corydaline group, but are supported by the results of the examination of other alkaloids.

Alkaloids which differ essentially in structure, even when their molecular formulæ are the same, give dissimilar spectra, whilst alkaloids which are closely related structurally give similar spectra, and sometimes, when the structural resemblance is very close, spectra which are indistinguishable from one another,

Stereoisomeric alkaloids give identical spectra. In the examination of stereoisomeric phenomena, the spectroscope affords a means of determining whether two substances of the same formula, the one active and the other inactive, are related to one another as stereoisomerides. If they give different spectra, it can be inferred with great certainty that they differ structurally.

Homologous alkaloids give practically the same spectra. The formula of bulbocapnine differs from that of tetrahydroberberine and papaverine only by CH_2, but the wide difference between the spectra of all three substances precludes the possibility that bulbocapnine is homologously related to either. Whilst important differences of structure are always accompanied by marked differences in the spectra, many of the structural details of an alkaloid may be modified without any appreciable effect being produced in the spectra. An example of this is afforded by the replacement of two of the methoxyl groups of corydaline by the dioxymethylene group in berberine. When, therefore, two alkaloids give spectra which are nearly, but not quite, identical, it may be inferred with considerable probability that they differ only in minor details of structure. In such cases, a preliminary spectroscopic examination would sometimes give a clue to the constitution of an alkaloid which would greatly facilitate the chemical investigation.

*3. "*The Absorption Spectra of Laudanine and Laudanosine in relation to their Chemical Constitution.*" By J. J. Dobbie and A. Lauder.

In this paper, the absorption spectra of laudanine, $C_{20}H_{25}O_4N$, and laudanosine, $C_{21}H_{27}O_4N$, two rare opium alkaloids discovered by Hesse, are described. They are shown to be practically identical with one another, and, further, to resemble very closely the spectra of corydaline and tetrahydropapaverine (see preceding abstract). The close resemblance between the spectra of laudanine and laudanosine confirms the view that they are homologous bodies, whilst the close agreement with the spectra of corydaline and tetrahydropapaverine points to the possession of a structure similar to that of these alkaloids.

For reasons given below, the relationship with corydaline is probably somewhat closer than with tetrahydropapaverine. Laudanosine has one atom of carbon less than corydaline, the number of hydrogen, oxygen, and nitrogen atoms being the same in both. Assuming the formulæ of the two alkaloids to have been correctly determined, the difference between them may conceivably consist in the absence from laudanosine of the methyl group which is present in corydaline and in the partial reduction of one of its rings,—

$$\underset{\text{Corydaline.}}{C_{22}H_{27}O_4N} - CH_2 + H_2 = \underset{\text{Laudanosine.}}{C_{21}H_{27}O_4N}.$$

In this way, the close agreement of the spectra might be accounted for. The absence of the methyl group would produce no appreciable effect, and it is known from the examination of a number of cases that the introduction of two atoms of hydrogen into a molecule is not necessarily accompanied by any notable modification of its spectra. The spectroscopic evidence as to the close relationship subsisting between laudanosine and corydaline is substantiated by the little which is known concerning the chemistry of the former alkaloid. Like corydaline, it contains four methoxyl groups, and yields metahemipinic acid as one of its oxidation products. It further resembles corydaline in the ease with which it is oxidised by nitric acid to a yellow base. This basic product has not been analysed, but it is not improbably identical with meconidine, an alkaloid associated with laudanosine in opium. The formula of meconidine is $C_{21}H_{25}O_4N$, and bears the same relationship to that of laudanosine that the formulæ of dehydrocorydaline and berberine respectively bear to those of corydaline and tetrahydroberberine.

Colourless:—

Corydaline.	Tetrahydroberberine.	Laudanosine.
$C_{22}H_{27}O_4N$.	$C_{20}H_{21}O_4N$.	$C_{21}H_{27}O_4N$.
M. p. 135·5°.	M. p. 167°.	M. p. 89°.

Yellow:—

Dehydrocorydaline.	Berberine.	Meconidine.
$C_{22}H_{23}O_4N$.	$C_{20}H_{17}O_4N$.	$C_{21}H_{23}O_4N$.
M. p. 118—120°.	M. p. 145°.	M. p. 58°.

Whether the yellow substance produced by the oxidation of laudanosine is identical with meconidine or not, the mere fact of the existence in opium of the coloured base having a formula differing from that of laudanosine by four atoms of hydrogen affords support to this view of the relationship of these substances, and this hypothesis receives additional confirmation from a comparison of the melting-points of the substances.

Discussion.

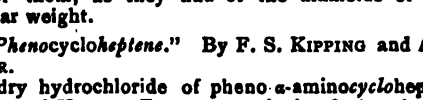
Dr. Jowett asked if the authors had tried the method with stereoismeric alkaloids like atropine and hyoscyamine or the scopolamines, or whether the method had been confined to those alkaloids with a quinoline or *iso*-quinoline nucleus. If the method was of general application, it would prove of great service in distinguishing between stereoisomerides and isomeric alkaloids differing structurally.

Professor Dunstan remarked that Dr. Dobbie had made a distinct step in advance in the direction of showing how these absorption spectra, for a knowledge of which chemists owe so much to Professor Hartley, may be definitely utilised as a criterion in determining the general molecular structure of alkaloids. Though possibly of limited application, the method promised to be of value in dealing with cases, such as those now brought forward by Professor Dobbie, where chemical methods were not yet available or applicable.

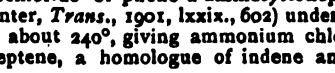
Professor Dobbie, in reply, said that although he and Mr. Lauder had incidentally examined some of the pyridine alkaloids, they had not made any systematic study of them, as they had of the alkaloids of high molecular weight.

4. "*Phenocycloheptene*." By F. S. Kipping and A. E. Hunter.

The dry hydrochloride of pheno-α-amino*cyclo*heptane (Kipping and Hunter, *Trans.*, 1901, lxxix., 602) undergoes decomposition at about 240°, giving ammonium chloride and pheno*cyclo*heptene, a homologue of indene and of dihydronaphthalene:—



Phenocyclopentene. (Indene). Phenocyclohexene. (Dihydronaphthalene).



Phenocycloheptene.

Phenocycloheptene, $C_{11}H_{12}$, a colourless liquid having an odour which recalls that of indene, boils at 233·5—234° (757 m.m.), and has a sp. gr. 1·009 at 4°/4°. It differs from indene in chemical properties, as it neither gives a picrate nor a condensation product with benzaldehyde in presence of sodium ethoxide.

On oxidation with potassium permanganate in alkaline solution at the ordinary temperature, phenocycloheptene is converted into an acid identical with the phenylbutyric-*o*-carboxylic acid, $CO_2H{\cdot}C_6H_4{\cdot}[CH_2]_3{\cdot}CO_2H$, prepared synthetically by Roser (*Ber.*, 1885, xviii., 3118); this acid seems to be dimorphous, as, when first produced, it crystallises in needles melting at 122°, and subsequently in plates melting at 138°, the latter being the form obtained by Roser, but the conditions which determine the formation of the one or other modification could not be ascertained. On oxidation with hot, very dilute nitric acid, the unsaturated hydrocarbon gives the form melting at 138°.

5. "*The Influence of Molybdenum and Tungsten Trioxides on the Specific Rotations of* l-*Lactic Acid and Potassium* l-*Lactate*." By G. G. Henderson and J. Prentice.

Both molybdenum trioxide and tungsten trioxide are dissolved by a hot aqueous solution of potassium *l*-lactate, the former readily, but the latter with greater difficulty. In each case, the specific rotation increases with the quantity of oxide in solution, and reaches a maximum ($[\alpha]_D$ 20° = +22·69° and +10·8° respectively) when the substances are present in the proportion of 2 molecules of $C_3H_5O_3K$ to 1 molecule of RO_3. At this point, the solutions are practically saturated with the oxides, for, although a little more of each oxide can be dissolved in the heat, decomposition then ensues, and the solutions become coloured blue or brown according as molybdenum or tungsten trioxide is used. These results point to the formation of potassium molybdilactate and tungstilactate according to the equation:—

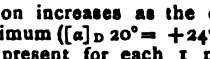
$$2C_3H_5O_3K + RO_3 = RO_2(C_3H_4O_3K)_2 + H_2O.$$

Sodium molybdate and tungstate are readily dissolved by an aqueous solution of *l*-lactic acid, the specific rotation increasing in each case as larger quantities of the salt are added. The highest readings ($[\alpha]_D$ 20° = +21·15° and +9·9°) are obtained when the solutions contain 1 molecule of Na_2RO_4 for each 2 molecules of $C_3H_6O_3$, and if a larger quantity of either salt is added the rotation diminishes. It seems, therefore, that a reaction occurs in the sense of the equation—

$$2C_3H_6O_3 + Na_2RO_4 = RO_2(C_3H_4O_3Na)_2 + 2H_2O,$$

sodium molybdilactate and tungstilactate being formed.

Molybdenum trioxide is also dissolved by an aqueous solution of *l*-lactic acid, but the compound formed in the solution is decomposed by exposure to heat or even to diffused daylight, and hence the process of dissolution must be carried on in the cold and in a dark place. The specific rotation increases as the oxide is added, and reaches a maximum ($[\alpha]_D$ 20° = +24·78°) when 1 molecule of MoO_3 is present for each 1 molecule of $C_3H_6O_3$, diminishing again on the addition of more oxide. This result indicates the formation of a compound $CHMe(CO_2H)O{\cdot}MoO_2{\cdot}OH$, or more probably—



The sensibility to light of the solution is so great that a good print from a negative can be taken on paper saturated with the solution and dried in the dark, but the blue colour of the print fades away in the absence of light.

Tungsten trioxide was found to be practically insolubie in an aqueous solution of *l*-lactic acid.

According to the views formerly expressed (*Trans.*, 1899, lxxv., 542) regarding the constitution of the "tartar emetic" class of compounds, molybdenum and tungsten

trioxides should react with lactates, yielding derivatives of the type $RO_2(O{\cdot}CHMe{\cdot}CO_2M)_2$, and the results of this investigation point to the formation of compounds having this composition.

6. "*Estimation of Ethyl Alcohol in Essences and Medicinal Preparations.*" By T. E. THORPE and JOHN HOLMES.

The authors described a method of estimating ordinary alcohol in essences and medicinal preparations containing essential oils and volatile substances, such as ether, chloroform, benzaldehyde, camphor, compound ethers, and which has been used for some time past in the Government Laboratory, and which has been found to be both accurare and of very general applicability.

It is as follows:—Twenty-five c.c. of the sample, measured at 15·5°, are mixed with water in a separator to a bulk of from 100 to 150 c.c., and common salt is added in sufficient quantity to saturate the liquid. The mixture is now shaken vigorously for five minutes with from 50 to 80 c.c. of light petroleum boiling below 60°, and after standing for about half-an-hour the lower layer is drawn off into another separator, extracted, if necessary, a second time with petroleum, and then introduced into a distillation flask. Meanwhile, the petroleum layers are washed successively with 25 c.c. of saturated brine, the washings added to the main bulk, which is neutralised if necessary, and then distilled, and the distillate made up to 100 c.c. and its relative density determined at the standard temperature in the usual manner. The results thus obtained require a small correction from the circumstance that, as the alcohol present is distilled into four times its initial volume, the errors of the spirit tables are necessarily quadrupled. Details were given of the mode in which the magnitude of this error may be determined, and from these results the mean error of the tables at below 40 per cent proof (for example, 0·972 sp. gr.), which is the particular section of tables mainly used, may be set down as +0·2 per cent of proof spirit, and hence the observed determinations, expressed as percentages of proof spirit, require a subtractive correction of 0·8 per cent.

Tables were given of results obtained on preparations actually made in the laboratory and containing known quantities of ethyl alcohol, as evidence of the accuracy and general applicability of the method and of the degree of variation which may be expected to occur between the results of different operators.

7. "*Carbon Monoxide as a Product of Combustion of the Bunsen Burner.*" By T. E. THORPE.

The author, in the course of an inquiry into the nature of the combustion-products of certain of the gas- and oil-stoves in common use, has had occasion to make observations on the behaviour of the Bunsen burner as regards its liability to evolve carbon monoxide when burning under an ordinary laboratory sand-tray. He finds that a burner fed with coal-gas at the rate of 6 cubic feet per hour, and under 0·95 inch pressure, will evolve about 0·022 cubic foot of carbon monoxide when burnt under a sand-tray in such manner that the inner cone of the flame impinges, or apparently impinges, on the metal.

8. "*Derivatives of β-Resorcylic Acid and of Protocatechuic Acid.*" By W. H. PERKIN, junr., and E. SCHIESS.

The authors have been engaged for some time in the investigation of some derivatives of these acids, and the appearance of a paper by Bülow and Reiss (*Ber.*, 1902, xxxv., 3900), which deals with somewhat similar derivatives obtained from α-resorcylic acid, has necessitated the publication of the following short account of their results:—

Methyl dimethyl-β-resorcylate, $(OMe)_2C_6H_3{\cdot}CO_2Me$, is readily obtained as a colourless oil boiling at 160—162° under 13 m.m. pressure when β-resorcylic acid is treated with potassium hydroxide and methyl sulphate in aqueous solution. The corresponding ethyl dimethyl-β-resorcylate boils at 170° under 13 m.m. pressure.

2 : 4-*Dimethoxybenzoylacetophenone*,—

$$(OMe)_2C_6H_3{\cdot}CO{\cdot}CH_2{\cdot}COPh,$$

is produced when sodium acts on a mixture of ethyl dimethylresorcylate and acetophenone dissolved in dry ether; it crystallises in plates, melts at 55°, and develops a brownish-red colouration with alcoholic ferric chloride. The ethereal solution gives, with copper acetate, the copper compound $C_{34}H_{30}O_8Cu$, which crystallises from benzene in slender, green needles containing 1 molecule of benzene.

2 : 4-*Dimethoxycinnamic acid*,—

$$(OMe)_2C_6H_3{\cdot}CH{:}CH{\cdot}CO_2H,$$

which has already been obtained from methylumbelliferone by Will and Tiemann (*Ber.*, 1882, xv., 2080; 1883, xvi., 2116) in two modifications (α- and β-) melting respectively at 138° and 184°, may be easily prepared synthetically by digesting dimethylresorcylaldehyde (2 : 4-dimethoxybenzaldehyde), $(OMe)_2C_6H_3{\cdot}CHO$, with sodium acetate and acetic anhydride in the usual manner. The acid obtained in this way by the authors was the β-modification melting at 184°.

The *ethyl* salt, $(OMe)_2C_6H_3{\cdot}CH{:}CH{\cdot}CO_2Et$, is very conveniently prepared, in a yield of 80 per cent, by treating a mixture of dimethylresorcylaldehyde and ethyl acetate with sodium (compare Claisen, *Ber.*, 1890, xxiii., 977); it is a colourless oil distilling at 208° under 13 m.m. pressure.

3 : 4-*Dimethoxycinnamic acid* may be obtained by treating dimethylcatecholaldehyde (3 : 4-dimethoxybenzaldehyde) in a similar manner; it crystallises from acetic acid in needles, melts at 180°, and is identical with the acid which Tiemann and Will (*Ber.*, 1881, xiv., 960) first prepared from caffeic and ferulic acids by treatment with potassium hydroxide and methyl iodide. Its *ethyl* salt may be prepared from the acid by esterification in the usual manner, but much more conveniently by acting on a mixture of dimethylcatecholaldehyde and ethyl acetate with sodium. It crystallises from light petroleum in plates, melts at 59°, and distils at 196—197° under a pressure of 11 m.m.

Ethyl 3 : 4-*dimethoxyphenyl* α : β-*dibromopropionate*, $(OMe)_2C_6H_3{\cdot}CHBr{\cdot}CHBr{\cdot}CO_2Et$, which is formed when the last-mentioned ethyl salt is treated with bromine in chloroform solution, melts at 111°, and, when hydrolysed with excess of alcoholic potash, is converted into 3 : 4-*dimethoxyphenylpropiolic acid*, $(OMe)_2C_6H_3{\cdot}C{:}C{\cdot}CO_2H$, a colourless, crystalline substance melting at 149°. A detailed investigation of the above substances and their derivatives is in progress.

(To be continued).

The Solvent and Dissociating Properties of Liquid Cyanogen and of Liquid Hydrocyanic Acid.—M. Centnerszwer.—By means of experiments with a large number of mineral and organic substances, the author has confirmed the fact, already established by Gore in 1872, that liquid cyanogen is only a mediocre solvent, and that most bodies are insoluble therein. Correlatively with this fact he has found a very low value for the electric conductivity of liquid cyanogen; it is less than $0{\cdot}7 \times 10^{-8}$. This conductivity is not increased by the addition of salts. If we accept the hypothesis put forward in 1897 by Dutoit and Aston (*Comptes Rendus*, vol. cxxv., p. 240), it results from these facts that the molecule of liquid cyanogen should not be represented by the formula C_2N_2, like gaseous cyanogen, but by the formula CN, or a similar formula. On the other hand, liquid hydrocyanic acid is a good solvent for many substances, and its electric conductivity is much greater, $0{\cdot}496 \times 10^{-6}$. Hydrocyanic solutions of iodide of potassium and of iodide of trimethylsulphine are, on an average, four times better conductors than the corresponding aqueous solutions at a similar concentration and at the same temperature.—*Zeit. Physik. Ch.*, vol. xxxix., p. 217.

NOTICES OF BOOKS.

Theoretical Organic Chemistry. By Julius B. Cohen, Ph.D. London: Macmillan and Co., Ltd. 1902.

The chief difference between this book and the host of other text-books of organic chemistry of about the same scope and difficulty is the large importance attached in it to the consideration of industrial processes and products, which will make it specially useful to teachers and students in technical schools and colleges. Details for performing a great number of experiments are interspersed in the text, though the title gives no suggestion of this feature; these seem to be carefully described and well chosen, and will probably be found sufficient to form an elementary laboratory course in organic chemistry. The general style in which the book is written recalls the descriptive class of text-book, which is apparently now rapidly becoming obsolete and is giving way before those which advocate the research method of studying chemistry. At the end of each chapter there is a collection of questions of the familiar type on the matter contained in it; many of these questions are drawn from University B.Sc. pass-papers, and from the papers of the Board of Education. The book appears to be generally very trustworthy in matters of detail, though the percentage composition of butter given on page 164 cannot be regarded as representing the average, and should be corrected in a future edition. Though no doubt the book will be found useful in preparation for examinations, it would probably be better employed as a book of reference for teachers, than as one to be put into the hands of the students themselves, except in so far as the practical portions, which are very good, are concerned.

Handbuch der Elektrochemie. Specielle Elektrochemie. Lieferung I. ("Manual of Electro-chemistry." Special Electro-chemistry. Part I.). By Dr. H. Danneel. Halle, A.-S.: Wilhelm Knapp. 1903.

With the publication of this volume begins a new manual of electrochemistry which is to give a complete account of all that has hitherto been done in this region. The work is to be issued at intervals in 175 parts, and it is anticipated that it will be finished in about two years. The divisions of the subject are classed under nine headings, which are to be undertaken by eight distinguished collaborators, and every effort will be made to ensure the adequate treatment of every branch. This volume is the first number of the Special Electro chemistry of the elements and their inorganic compounds, and contains details of the preparation of hydrogen and its compounds with oxygen, the halogens and sulphur, also sulphuric and nitric acids, the results of the electrolysis of these compounds being also described. A large portion of the volume is occupied by the consideration of methods of electrolysis of water and its purification by electrical means. If the same standard of excellence is maintained throughout as is reached in this volume, the Handbuch should prove most acceptable to all who are interested in this branch of chemistry.

Beiträge zur Chemischen Physiologie und Pathologie ("Contributions to Chemical Physiology and Pathology"). Edited by Franz Hofmeister. Band III. Heft 7 and 8. Braunschweig: Friedrich Viewig und Sohn. 1902.

This number of the *Beiträge* contains an important paper by Waldemar Stade describing his researches on the ferment, capable of decomposing fats, which exists in the stomach. These researches were undertaken at the instigation of Volhard, who combats the view that this decomposition is due to the action of putrefactive organisms; the author of the paper examines the conditions of action of the supposed unorganised ferment of the gastric juice, and confirms Schütz and Borissow's law connecting the amount of the products of digestion and the square root of the quantity of ferment present. He also formulates a further relation involving the time of action of the ferment. This new law is identical with that discovered by Huppert and Schütz in the course of their recent investigations on the quantitative proportions which obtain in the case of pepsin digestion.

The number also contains amongst others an interesting article on the behaviour of substituted toluenes and amidobenzoic acids in the organism, and a short paper dealing with the determination of hippuric acid, when present only in minute quantities, when Bunge and Schmiedeberg's method does not give good results.

Einführung in die Elektrochemie. ("Introduction to Electrochemistry"). By Peter Gerdes. Halle, A.-S.: Wilhelm Knapp. 1902.

This book is an elementary introduction to electrochemistry, and aims at preparing the student for the task of grappling with more advanced works.

The treatment of the subject is based upon the theory of ionic dissociation, and only the most important electrical laws and theories are considered. The elements of electricity and magnetism are briefly dealt with, chiefly from a practical point of view, and occupy a greater portion of the book than that devoted to the consideration of electro-chemistry proper. At the commencement the book appears to be of a most elementary nature, the simplest language being used in description, but this character is not kept up throughout the volume, which is thus very uneven as regards difficulty; for instance, the wording of the chapter on osmosis and osmotic pressure is not as clear as it might be, and a few diagrams would do much towards rendering the explanations more easily understood. The beginner would also certainly require a good deal of help in the manipulation of some of the experiments to be performed, and at times considerable additional verbal instruction.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 3, January 19, 1903.

Researches on the Alkaloids of Quinquinas: Quinine and Quinidine. — MM. Berthelot and Gaudechon.—The authors undertake a thermo-chemical investigation of the principal alkalis of quinquinas:—Quinine, quinidine, cinchonine, cinchonidine, and cinchonamine. The composition of all the substances used in this research has been carefully verified by complete analysis. The authors determine first the heat of combustion of the alkalis and their formation from their elements, then the heat of formation of their salts in the solid state, both anhydrous and hydrated, and in solution. These observations throw a new light on the constitution of the natural polyamines of the quinine order, compounds analogous to the ethylenediamines, and on the various degrees of their neutralisation by alkalis. They also throw light on the molecular changes of composition of organic bases from the first moment of their precipitation —changes which are comparable in a certain degree to those of precipitated metallic oxides. The isomerism between the organic alkaloids, such as quinine, compared with quinidine and cinchonine compared with cinchonidine, has been an object of special study; also a comparison between similar groups of alkalis whose composition is different.

Method of Formation of Phenols.—F. Bodroux.—When an organo-magnesium compound is left exposed to

the air it rapidly undergoes decomposition. The water-vapour in the atmosphere decomposes it, liberating hydrocarbon, and at the same time the oxygen of the air acts in the following way:—$\frac{R}{Br}>Mg+O=\frac{R-O}{Br}>Mg$. An excellent example of this reaction is when phenyl-magnesium bromide is treated in the above manner. At the end of a few hours a strong odour of phenol is observed. The compounds thus formed are destroyed by the hydrochloric acid, and an alcohol or phenol is liberated:—$\frac{R-O}{Br}>Mg + HCl = \frac{Cl}{Br}>Mg + R—OH$. The author studies these reactions for various other organo-metallic compounds.

Ethyl Dinitroacetate.—L. Bouveault and A. Wahl.—In a previous paper the authors described the preparation of ethyl nitroacetate by the decomposition of α-ethyl nitrodimethylacrylate under the influence of gaseous ammonia. This method, although giving very good results, necessitates a long series of manipulations. They have therefore devised a method of preparing nitroacetic ether in an easier manner.

MISCELLANEOUS.

Society of Electro-Chemists and Metallurgists.—The new Society of Electro-Chemists was successfully inaugurated last Wednesday at the General Meeting held at St. Ermin's Hotel. After a few introductory remarks had been made by Mr. James Swinburne, Pres. Inst. E.E., the formal motion that the Society be formed was moved by Mr. Joseph Swan, F.R.S., and seconded by Mr. Alexander Siemens. It was stated that similar organisations for the promotion of electro-chemical science and practice had been in existence for a considerable time both in Germany and the United States. The seriousness of adding to the already very great number of existing scientific societies had been keenly felt by the provisional Committee, but up to the present, at any rate, owing to the peculiar nature of the sciences of electro-chemistry and electro-metallurgy, no satisfactory *modus vivendi* had been arrived at for affiliation with an existing organisation. The following Council was unanimously elected:—President—J. W. Swan, F.R.S. Vice-Presidents—Prof. A. Crum-Browne, M.D., D.Sc., F.R.S.; Lord Kelvin, G.C.V.O., F.R.S.; Sir Oliver T. Lodge, D.Sc., F.R.S.; Ludwig Mond, Ph.D., F.R.S.; Lord Rayleigh, D.C.L., F.R.S.; Alexander Siemens, M.Inst.C.E.; J. Swinburne, Pres. I.E.E., M.Inst.C.E. Council — George Beilby; Bertram Blount; A. G. Charleton, Pres. I.M.M.; W. R. Cooper, M.A., B.Sc.; Sherard Cowper-Coles; F. G. Donnan, M.A., Ph.D.; Prof. A. K. Huntington; R. A. Lehfeldt, D.Sc.; F. Mollwo Perkin, Ph.D.; W. S. Squire, Ph.D.; O. J. Steinhart, Ph.D. Intending members are requested to send their names to the Hon. Sec., Mr. F. S. Spiers, 82, Victoria Street, S.W.

Science Abstracts.—We are informed that *Science Abstracts* will be published in future in two sections:—*Section* A.—Physics, embracing Light, including Photography, Heat, Sound, Electricity and Magnetism, Chemical Physics and Electro-chemistry, General Physics, Meteorology and Terrestrial Physics, Physical Astronomy. *Section* B.—Embracing Steam Plant, Gas and Oil Engines, Automobiles, Oil Engine driven ships and launches, Balloons and Air-ships, General Electrical Engineering, including Industrial Electro-chemistry, Electric Generators, Motors, and Transformers, Electrical Distribution, Traction and Lighting, Telegraphy and Telephony. We understand that the American Physical Society is now joined with the Institution of Electrical Engineers and the Physical Society of London in the direction of the publication, and has elected Professor E. H. Hall, of Harvard University, as its representative on the publishing Committee.

The Batavian Society of Experimental Philosophy of Rotterdam.—At the General Meeting of this Society on September 20th, 1902, a number of questions were proposed for solution, and a prize offered for the answer to one or more which may be judged the best. The questions, 49 in number, include all kinds of scientific subjects of interest. The prize offered is the Society's Gold Medal weighing 30 ducats, or its equivalent value (about £14), at the option of the winner. Answers must not be in the handwriting of the competitors, but must be marked with a distinctive motto, and accompanied by a sealed packet containing a copy of the motto, and the name and address of the sender, and must be sent to the Secretary, Dr. G. J. W. Bremer, at Rotterdam, by February 1st, 1904.

Ferric Oxide and its Hydrates.—O. Ruff.—The author constructed a small block of steel having a cavity lined with copper; it was closed with a screw enabling a pressure of 5000 atmospheres to be applied. In this cavity he placed water (either pure or containing different salts), holding precipitated ferric hydrate in suspension; the apparatus was closed and the pressure applied, and the whole exposed for several days to known temperatures up to 100°. Under these conditions the red colloidal hydrate was converted, after about twenty days, into limonite or rust, $Fe_2O_3.\frac{1}{2}H_2O$, if the temperature was kept below 42·5°, while with a temperature between 42·5° and 62·5° gœthite, $Fe_2O_3.H_2O$, was obtained, and at temperatures above 62·5°, hydrohæmatite, $Fe_2O_3.\frac{1}{2}H_2O$; in fact, the formation of these different hydrates depends on the vapour tension of the water-vapour. But under the ordinary pressure the red colloidal hydrate should be doubtless first completely dehydrated before coming to the state of limonite, which is the only really stable hydrate.—*Berichte*, vol. xxxiv. p. 3417.

MEETINGS FOR THE WEEK.

Monday, 16th.—Society of Arts, 8. (Cantor Lectures). "Paper Manufacture," by Julius Hübner.

Tuesday, 17th.—Royal Institution, 5. "The Physiology of Digestion," by Prof. Allan Macfadyen, M.D.

—— Society of Arts, 8. "Heraldry in Decoration," by George W. Eve, A.R.E.

Wednesday, 18th.—Society of Arts, 8. "Three-colour Printing," by Harvey Dalziel.

—— Chemical, 5.30. "The Molecular Re-arrangement of N-Substituted Imino-ethers" and "The Nature and probable Mechanism of Metal Replacement in Tautomeric Compounds," by G. D. Lander. "The Chlorine Derivatives of Pyridine—Part VIII., The Interaction of 2 : 3 : 4 : 5-Tetrachlorpyridine with Ethyl Sodiomalonate," by W. J. Sell and F. W. Dootson. "The Biological Method for resolving Inactive Acids into their Optically Active Components," by A. McKenzie and A. Harden.

Thursday, 19th.—Royal Institution, 5. "Arctic and Antarctic Exploration," by Sir Clements Markham, K.C.B., F.R.S.

Friday, 20th.—Royal Institution, 9. "The Measurement of Energy," by Principal E. H. Griffiths, Sc.D., F.R.S.

Saturday, 21st.—Royal Institution, 3. "Dramatic Criticism," by Arthur B. Walkley.

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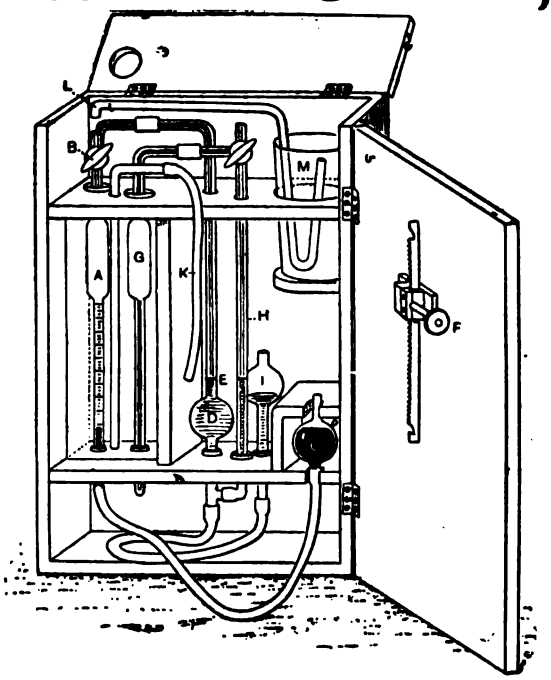

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THE

CHEMICAL NEWS

AND

JOURNAL OF PHYSICAL SCIENCE

Edited by Sir Wm. Crookes, F.R.S. (WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE") *Established Fifty-eight Years.*

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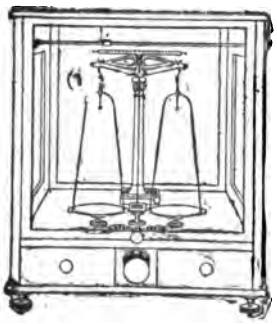

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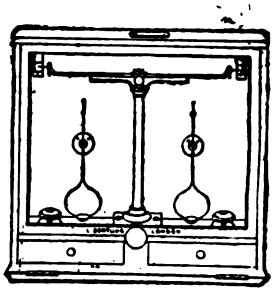

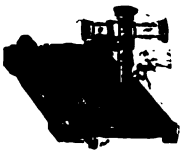

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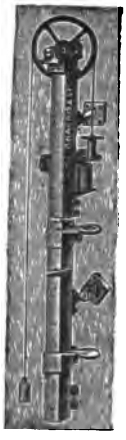

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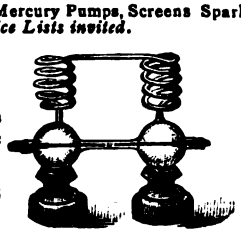

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THE CHEMICAL NEWS.

VOL. LXXXVII., No. 2255.

REVISION OF THE ATOMIC WEIGHT OF LANTHANUM.*

By BOHUSLAV BRAUNER, Ph.D., and FRANTIŠEK PAVLÍČEK, Bohemian University, Prague.

(Concluded from p. 74).

Third Method of Atomic Weight Determination.

In 1882, Stolba (*Abhandl. Königl. Böhm. Ges. Wissensch.*) proposed a new method for the determination of the atomic weight of lanthanum and other rare earth elements (Ce, Di). In one part of the dry oxalate the percentage of R_2O_3 (or CeO_2) is determined by calcination, and in another that of C_2O_3, with permanganate in sulphuric acid solution.† This method was described for a second time as new by W. Gibbs in 1893 (*Proc. Amer. Acad.*, xxviii., 260). Lanthanum material was purified by Shapleigh by the Mendeleeff-Auer method, and the oxalate washed with a large quantity of hot water. The oxalates were dried on a water-bath, and then thoroughly mixed. The mean atomic weight of lanthanum found by this method by Gibbs was La = 139·70. Gibbs states that Dr. Shapleigh found, with the same material by the sulphate method, La = 139·71.

Stolba's method was used by me with very good results for the determination of the atomic weights of cerium, thorium, and praseodym, and I thought, therefore, that it might serve as a method of control in the case of lanthanum. But it was necessary to consider the question whether the lanthanum material used by Gibbs really contained an earth with a much higher atomic weight, or whether the composition of his oxalate was abnormal.

The Fractions La 0 to La 7, into which our purest lanthanum material had been divided, were thrown down as oxalates by adding an excess of pure oxalic acid to a hot dilute solution of lanthanum nitrate. After pouring off the supernatant liquid, the precipitate was digested with oxalic acid solution. A perforated round platinum plate, 2 c.m. in diameter, covered with a slightly larger piece of smooth round filter-paper, was used for collecting the oxalate on the pump. It was washed, first with dilute oxalic acid solution, then with *cold*, *tepid*, or *hot* water, which mode of washing has an influence on the composition of the precipitate, as will be noticed further on, and finally with pure alcohol rectified in the presence of tartaric acid.

Oxalates prepared in this way may be obtained perfectly *air dry* and *homogeneous* after standing for a few hours in the open air (covered with paper), an important circumstance when different portions are to be weighed out for different determinations. These conditions are not fulfilled when the oxalates are dried on the water-bath as recommended by Gibbs.

In converting the oxalate into the oxide, it must be heated very gently and gradually, beginning from the lid in order to avoid a loss of the fine powder which is easily carried away with the escaping gases. It appears, however, that it is sometimes difficult to obtain a perfectly pure oxide as soon as its quantity exceeds 1 grm., and the "personal error" due to two different observers may not be without influence on the slight deviations in the percentage of oxide from the same oxalate.

For the determination of the oxalic radicle, C_2O_3, the oxalate was heated in an Erlenmeyer flask with 50 c.c. of 12 per cent sulphuric acid and titrated with permanganate with special precautions into which I cannot enter here. The permanganate was standardised many times with ammonium oxalate under exactly the same conditions. The salt was repeatedly re-crystallised from hot water, finally in the presence of free ammonia, in order to prevent the formation of the acid salt. The results are given in Table V.

The differences between the atomic numbers obtained are very considerable, being equal to a maximum of 1·25, and yet, after excluding the abnormal results obtained with Fraction La 4, a mean value La = 139·07 is found, identical with the true atomic weight of lanthanum.

The differences are due to the different composition of the individual oxalates, and this depends on the temperature of the water used for washing them. With an increase in the temperature of the water, the quantity of the water of crystallisation of the oxalates is found to diminish and the atomic number to rise, as is seen from Table VI.

The abnormal composition of the oxalate is most prominent in Fraction La 7, which yielded the atomic number La = 139·66. The oxalate was washed with hot water, and formed a heavy crystalline powder. It must have consisted partly of a basic oxalate, which was probably formed by the hydrolysis of an oxalonitrate.

As this number is identical with that obtained by Gibbs, namely, La = 139·7, from an oxalate which was prepared exactly in the same way, it is unnecessary to assume that this number represents the real atomic weight of lanthanum contained in the material used by him.

On the other hand, the abnormally low results obtained in our series from the oxalates washed with cold water, namely, La 1, La 5, and La 6, point to the presence of free oxalic acid in the oxalates used, undoubtedly due to absorption.

A normal atomic number was obtained, probably by chance only, from the fractions La 0 and La 3.

An examination of the same lanthanum material which, in Dr. Shapleigh's hands, gave the abnormally high number La = 139·7 by the sulphate method, and which was presented to me by him, has shown that this material is not quite free from foreign earths, especially from traces of the constituents of didymium, so that even this high number finds an explanation.

It is seen from Table VI. that pure precipitated lanthanum oxalate very probably contains 11 mols. of water, as stated by Wyrouboff (*Bull. Soc. Franc. Min.*, 1895, xxiv., 110), who also prepared an oxalate with $3H_2O$.

I obtained (*Trans.*, 1898, lxxiii., 974) by crystallisation from dilute sulphuric acid an oxalate with $7H_2O$, but the existence of a salt with $9H_2O$ as found by Czudnowicz and Cleve becomes improbable. It would seem that in fraction La 4 an oxalate with $6H_2O$ was present.

Is Lanthanum a Mixture of Elements?

The results of the present investigation enable me to answer this question as follows:—

1. Lanthanum material purified (*a*) by fractional crystallisation and re-crystallisation of its soluble salt with ammonium nitrate (Mendeléeff-Auer), (*b*) by fractional fusion with potassium and sodium nitrates at 450—500° (Debray-Schützenberger), and (*c*) split up into eight different fractions by partial precipitation with potassium hydroxide, contains only *one element*, the true lanthanum with the atomic weight La = 139·04 in a vacuum. The least basic fractions (especially La 7) may contain a slight admixture of an element with a higher atomic weight, which gives to the oxide a very pale buff tint, but this very small quantity has scarcely any influence on the atomic weight.

2. An element with the atomic weight 135, which was presumably found by some chemists, lastly by Schützenberger in 1895 in some fractions of lanthanum, *is not contained* in the pure lanthanum or in any of its side fractions, and it must be definitely stated that this low number could

* From the *Transactions of the Chemical Society*, 1902, vol. lxxxi.

† In this paper, Stolba finds for the first time that lanthanum oxide may be determined alkalimetrically with a good result.

TABLE V.—*Analyses of Lanthanum Oxalate.*

No. of experiment.	No. of fraction.	Lanthanum oxalate. Grms.	La_2O_3. Grms.	La_2O_3. Per cent.	C_2O_3. Grm.	C_2O_3. Per cent.	Ratio used for calculation.	Atomic weight* La =
31.	La 0	(*a*) 2·27247	1·06543	46·884	—	—	*a* : *c*	139·12
		(*b*) 2·14773	1·00676	46·876	—	—	*b* : *c*	139·09
		(*c*) 0·67462	—	—	0·20941	31·041	—	—
32.	La 1	(*a*) 2·0854	0·93205	44·722	—	—	*a* : *f*	138·77
		(*b*) 1·8823	0·8416	44·711	—	—	*b* : *f*	138·74
		(*c*) 1·92285	0·85993	44·694	—	—	*c* : *f*	138·67
		(*d*) 2·51643	1·12533	44·719	—	—	*d* : *f*	138·76
		(*e*) 3·80470	1·70246	44·746	—	—	*e* : *f*	138·86
		(*f*) 1·60083	—	—	0·47097	29·673	—	—
33.	La 2	(*a*) 1·7485	0·7847	44·879	—	—	*a* : *c*	138·90
		(*b*) 1·7983	0·80645	44·845	—	—	*b* : *c*	138·77
		(*c*) 1·30665	—	—	0·38879	29·755	—	—
34.	La 3	(*a*) 2·2325	1·0760	48·197	—	—	*a* : *b*	139·07
		(*b*) 1·14021	—	—	0·36395	31·920	—	—
35.	[La 4]	[(*a*) 2·1266]	[1·0683]	[50·235]	—	—	*a* : *c*	[138·94]
		[(*b*) 2·56509]	[1·28627]	[50·145]	—	—	*a* : *d*	[138·70]
		[(*c*) 1·24241]	—	—	[0·41368]	[33·297]	*b* : *c*	[138·65]
		[(*d*) 1·08010]	—	—	[0·36017]	[33·346]	*b* : *d*	[138·41]
36.	La 5	(*a*) 1·9488	0·8721	44·751	—	—	*a* : *b*	138·79
		(*b*) 0·89926	—	—	0·26698	29·689	—	—
37.	La 6	(*a*) 2·0880	0·9755	46·719	—	—	*a* : *c*	139·38
		(*b*) 1·9684	0·9188	46·678	—	—	*b* : *c*	139·24
		(*c*) 1·41521	—	—	0·43706	30·883	—	—
38.	La 7	(*a*) 1·9753	0·9507	48·129	—	—	*a* : *d*	139·65
		(*b*) 2·0111	0·9677	48·118	—	—	*b* : *d*	139·61
		(*c*) 2·21199	1·06469	48·133	—	—	*c* : *d*	139·66
		(*d*) 1·13639	—	—	0·36094	31·762	—	—
		Mean atomic weight after rejecting the results of Experiment 35 (La 4)						139·07

* When O=16, C=12·00, and N=14·04.

TABLE VI.—*Showing the Percentage Composition of the different Fractions of Lanthanum Oxalate, &c.*

Fraction..	La 1.	La 5.	La 2.	La 6.	La 0.	La 7.	La 3.	[La 4.]
La_2O_3 per cent	44·72	44·75	44·86	46·70	46·88	48·13	48·20	[50·19]
C_2O_3 per cent	29·67	29·69	29·76	30·88	31·04	31·76	31·92	[33·32]
H_2O per cent	25·61	25·60	25·38	22·42	22·08	20·11	19·88	[16·49]
Mols. H_2O	10·37	10·34	10·24	8·69	8·53	7·57	7·47	[5·95]
La, minimum	138·67	138·79	138·77	139·24	139·09	139·61	139·07	[138·41]
La, maximum	138·86	—	138·90	139·38	139·12	139·66	—	[138·94]

only be obtained from fractions which contained yttria, as shown by my chemical and optical experiments.

3. With regard to the fact that the least basic fractions, obtained from our lanthanum material by the second method of fractionation, yielded by the correctly applied sulphate method the numbers $R^{III}=139·27$ (experiment 14) and 139·20 (experiment 27), whilst the solution of this earth was perfectly free from any earth possessing an absorption spectrum, the conclusion may be drawn that in these fractions a small quantity of an element with a higher atomic weight than that of lanthanum is present.

This fact stands in the closest relation with that discovered by me twenty years ago (*Monatsh.*, 1882, iii., 486), that on fractionating the mixture of lanthanum and old didymium with ammonia, intermediate fractions, less basic than lanthanum, are obtained containing an element with a higher atomic weight than that of lanthanum. The numbers obtained from these fractions were $R^{III}=140·19$ and the maximum $R^{III}=140·63$. In the spark spectrum, new lines not belonging to lanthanum were observed.

These experiments were given up at that time for this reason: Cleve (*Bull. Soc. Chim.*, 1883, xxxix., 289) declared with the whole weight of his authority that between lanthanum and didymium no third element is contained. In this conclusion he was evidently wrong, and the question requires a new and thorough investigation.

Critical Remarks.

On casting a glance at the atomic weight determinations collected in Table I. in the introduction, the following explanation of the discrepancies may be offered:—

(i.). The determinations by Rammelsberg and Marignac (1), (2), and (3), and Holzmann (1) are founded on the precipitation of barium sulphate, which carries down a considerable quantity of lanthanum sulphate.

(ii.). Holzmann's determinations (2) and (3) are made from somewhat complicated salts.

(iii.). As regards the determinations of Czudnowicz and Erk (2), see (i.).

(iv.). Hermann's determinations (1), (2), and (3) are very near the truth, but a little high, probably because his lanthanum was not freed from its higher companion.

(v.). The numbers of Zschiesche, Erk (1) and Erk 2) are too low, very probably owing to the presence of yttria.

(vi.). Marignac's number (4) is too low owing to the very hygroscopic nature of the anhydrous sulphate and incomplete expulsion of water from the anhydrous salt.

(vii.). Cleve's number (1) is identical with that obtained by us from the fraction A5+6; see also (iv.).

(viii.). The numbers obtained by Gibbs and Shapleigh have been explained in an earlier section of this paper.

(ix.). The low numbers obtained by Brauner (1) and (2), Cleve (2), Bauer, Bettendorff, and probably by Schützenberger and Muthmann (although the last two chemists give no details about their work) are due to the formation of some acid sulphate and to the very hygroscopic nature of the anhydrous sulphate.

Having shown that the majority of the determinations of the atomic weight of lanthanum hitherto made are inexact, either because the material used was not quite pure or homogeneous, or because the method used for the determination was not free from error, the following important question arises:—

Are we entitled to use the whole series of determinations hitherto made for the final calculation, or may we not regard the number resulting from the present minute and detailed work, namely, La=139·04, as lying near the true atomic weight of lanthanum, awaiting, of course, its confirmation by other methods?

In conclusion, I may say that, having extended the research to other rare earths and their sulphates, I find this:—*All atomic weight determinations of the rare earth elements made by the synthetical sulphate method during the nineteenth century are vitiated by an error which tends to lower the atomic weight and diminishes as the basicity of the earth decreases.*

If the atomic weight of lanthanum is La=139·04, it is highly improbable that cerium would possess the same atomic weight, Ce=139, as assumed by Clarke from the result of the work of Wyrouboff and Verneuil, who obtained for a "bivalent" cerium the value Ce=92·7. This assumption has been proved to be correct by work specially done in our laboratory.

EXPERIMENTS ON THE PRODUCTION OF SULPHURETTED HYDROGEN IN ALCOHOLIC FERMENTATION.

By M. and E. POZZI-ESCOT.

If we add sulphur or a sulphate to a must in alcoholic fermentation, sulphuretted hydrogen is produced during the fermentation. This is due to the intervention of a reducing diastase called philothion.

It was of interest to ascertain at what particular moment of the fermentation the sulphuretted hydrogen was produced; that is to say, the diffusion of the reducing diastases.

One hundred grms. of compressed brewery yeast were taken, and—

1. After a series of washings the yeast was placed in a 1 litre flask containing water and 10 per cent of saccharose; this was shaken vigorously to get the yeast thoroughly spread throughout the mass, and the liquid was divided into two equal parts.

2. One portion of the liquor was placed in a flask and treated with an excess of flowers of sulphur, previously triturated with water, and well shaken; it was then left to stand at 25°, and, thanks to the preceding operations, it entered rapidly into fermentation; it was shaken up occasionally to help the fermentation, and sulphuretted hydrogen was tested for systematically during the progress of the operation; in this manner we found that it is towards the end of the time, when still a sixth part of the total sugar remained, that the sulphur is attacked to a noticeable extent.

3. The second portion was placed in a parchment paper diffuser, and the whole placed in a crystallising dish containing water, but as little water as possible should be used.

The object of this experiment is to ascertain the moment when the yeast diffuses its reducing diastase; to detect this in the apparatus, we made use of peroxide of hydrogen, which is a very sensitive reagent, as I have shown previously. Under these conditions we observe that the sucrose of the yeast commences to diffuse at the commencement of the experiment, but that it is only towards the end that the reducing diastase appears.

4. The conclusion arrived at from these experiments is that normally yeast does not let its reducing diastases exude, but that they are diffusible as soon as the vegetable ferment meets with an obstacle to its evolution; that is, with more or less paralysing substances; in a word, that during its active life the yeast retains its reducing elements, but that these enter into solution as soon as the fermenting power has reached its maximum, when the yeast is affected and ceases to be reproduced freely.—*Bull. Soc. Chim.*, Series 3, vol. xxvii., No. 13.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Wednesday, January 21st, 1903.

Prof. J. EMERSON REYNOLDS, Sc.D., F.R.S., President, in the Chair.

(Concluded from p. 82).

9. "*Synthesis of Imino-ethers. N-Ethyl-, N-Methyl-, and N-Benzylbenziminoethers.*" By G. D. LANDER.

Alkylation by means of silver oxide and alkyl iodides occurs to a very limited extent with the alkyl and benzyl benzamides, and the imino-ethers were therefore prepared from the imide chlorides by means of the sodium alkyloxides (*Trans.*, 1902, lxxxi., 591). The *N*-ethyl and *N*-methyl derivatives are contaminated with compounds of higher boiling-points containing a smaller percentage of carbon, which may be ortho-compounds of the type $CPh(OR)_2NHR'$. The purification of the imino-ethers is effected by warming with 1/10 molecule of acetic anhydride.

The *imide chloride* of *benzethylamide*, CPhCl:NEt, boils at 110—111° (15 m.m.), and gives, on treatment with aniline, *ethylphenylbenzenylamidine*, CPh(:NEt)·NHPh; this base, which melts at 74—76°, is also obtained by condensing aniline with the imino-ether; its platinichloride crystallises with $2H_2O$, and melts at 204°

N-Ethylbenzimino-ethyl ether, CPh(OEt):NEt, and *N-ethylbenziminomethyl ether*, CPh(OMe):NEt, boil at 105° and 97—100° under 11 m.m. pressure, and at 221—223° and 209—212° (uncorr.) under the ordinary pressure, respectively; they are colourless, limpid liquids of amine like odour.

Benzoyldiethylbenzenylamidine, CPh(:NEt)·NEt·COPh, a basic by-product of the imino-ether synthesis, crystallises in colourless prisms melting at 90—91·5° without decomposition; its *platinichloride* melts at 151—151·5°, and its solution, in dilute hydrochloric acid, gradually decomposes with the formation of benzoic acid, ethylamine, and a compound (m. p. 101—102°) not yet examined.

N-Methylbenziminomethyl ether, CPh(OMe):NMe boils at 94—95° under 12 m.m., and at 203—206° (uncorr.) under the ordinary pressure; the crude hydrochloride melts at 65—70°, regenerating benzmethylamide.

N-Methylbenziminoethyl ether, CPh(OEt):NMe, was not obtained pure; it boils at about 105° under 14 m.m., and at about 215° under the ordinary pressure.

- *Benzoyldimethylbenzenylamidine*,—

$$CPh(:NMe)\cdot NMe\cdot COPh,$$

which resembles the diethyl compound in crystalline form and properties, melts at 116—117·5; its *platinichloride* melts at 184—185°.

The *imide chloride of benzbenzylamide*, $CPhCl:NCH_2Ph$ (compare *Ber.*, 1897, xxx., 1788), decomposes, almost completely, on distillation into benzonitrile and benzyl-chloride, but the undistilled imide chloride condenses with aniline, yielding *phenylbenzylbenzenylamidine*, $CPh(:NCH_2Ph)\cdot NHPh$, which melts at 99—100°, and is identical with Beckmann and Fellrath's base obtained from benzphenylamide imide chloride and benzylamine, and also with the amidine formed by condensation of *N*-benzylbenzimino-ethyl ether with aniline. *Phenylmethyl-benzylbenzenylamidine*, $CPh(:NCH_2Ph)\cdot NMePh$, which is produced either from methylaniline and the imide chloride of benzbenzylamide, or by alkylating the above described amidine with methyl iodide, melts at 89—90°.

N-Benzylbenzimino-ethyl ether, $CPh(OEt):NCH_2Ph$, is a viscid, colourless, odourless oil, boiling at 186—188° under 12 m.m. pressure; the corresponding *methyl ether*, $CPh(OMe):NCH_2Ph$, boils at 178—180° under 11 m.m. pressure. These *N*-benzylbenzimino ethers, when left in contact with air, undergo oxidation to dibenzamide.

10. "*The Condensation of Phenyl Ethyl Ketone (Propiophenone) with Benzalacetophenone and of Acetophenone with Benzalpropiophenone.*" By R. D. Abell.

Phenyl ethyl ketone and benzalacetophenone condense under the influence of sodium ethoxide to form (i.) 2-phenyl-1-methyl-1:3-dibenzoylpropane, $C_{24}H_{22}O_2$ (prisms, m. p. 103·5—104·5°); (ii.) 2:4-diphenyl-1-methyl-1:3:5-tribenzoylpentane, $C_{39}H_{34}O_3$ (rhombic plates, m. p. 241—242°).

The former substance reacts with hydroxylamine to form a *dioxime*, $C_{24}H_{24}N_2O_2$ (needles, m. p. 204—205°), and with hydroxylamine hydrochloride to form 2:4:6-*triphenyl-3-methylpyridine*, $C_{24}H_{19}N$ (needles, m. p. 141—142°), this base yielding a *picrate* (yellow prisms, m. p. 190—191°) and a *hydrochloride* in colourless, hygroscopic needles.

Acetophenone and benzalpropiophenone in presence of sodium ethoxide react to form: (i.) 2-phenyl-1:3-dimethyl-1:3-dibenzoylpropane, $C_{25}H_{24}O_2$ (six-sided crystals, m. p. 162—163°, *Trans.*, 1901, lxxix., 936); (ii.) a mixture of 2-phenyl-1:3-dibenzoylpropane, $C_{23}H_{20}O_2$ (Kostanecki and Rossbach, *Ber.*, 1896, xxix., 1492), and 2-phenyl-1-methyl-1:3 dibenzoylpropane, $C_{24}H_{22}O_2$, crystallising in prisms melting at 93—94°; (iii.) 2-phenyl-1-methyl-1:3-dibenzoylpropane, $C_{24}H_{22}O_2$ (prisms, m. p. 103·5—104·5°); (iv.) 2:4-diphenyl-1-methyl-1:3:5-tribenzoylpentane, $C_{39}H_{34}O_3$ (rhombic plates, m. p. 241—242°); (iv.) 2:4-diphenyl-1-methyl-1:3:5-tribenzoylpentane, $C_{39}H_{34}O_3$ (rhombic plates, m. p. 241—242°); (v.) 2:4-diphenyl-1:3:5-tribenzoylpentane, $C_{38}H_{32}O_{31}$ (glistening prisms, m. p. 255—256°) (Kostanecki and Rossbach, *Ber.*, 1896, xxix., 1492); (vi.) benzoic acid; (vii.) a pink, viscid, acid liquid.

The two homologous 1:5-diketones indicated under (ii.) could not be separated by solvents, but were identified by means of the corresponding dioximes and pyridines, namely, the dioxime, $C_{25}H_{22}N_2O_2$ (needles, m. p. 163—164°), and 2:4:6-triphenylpyridine, $C_{23}H_{17}N$ (needles, m. p. 137—138°, Wislicenus and Newman, *Annalen*, 1898, cccii., 236), corresponding to 2-phenyl-1:3-dibenzoylpropane, and the dioxime, $C_{24}H_{24}N_2O_2$ (needles, m. p. 204—205°) and 2:4:6-triphenyl-3-methylpyridine, $C_{24}H_{19}N$ (needles, m. p. 141—142°), corresponding to 2-phenyl-1-methyl-1:3-dibenzoylpropane.

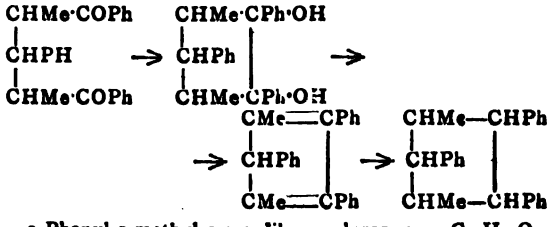
In presence of an alcoholic solution of sodium hydroxide, acetophenone and benzalpropiophenone reacted to form (i.) 2-phenyl-1:3-dimethyl-1:3-dibenzoylpropane, $C_{25}H_{24}O_2$ (six-sided crystals, m. p. 162—163°); (ii.) the mixture of homologous 1:5-diketones (prisms, m. p. 93—94°).

It is therefore evident that the reaction between acetophenone and benzalpropiophenone is not a condensation in the true sense of the word, and that the substances isolated are formed by the condensation of the decomposition products of benzalpropiophenone (phenyl ethyl ketone and benzaldehyde) with benzalpropiophenone and acetophenone.

11. "*A Synthesis of 1:3:5-Triphenyl-2:4-Dimethylcyclopentane and of 1:3:5-Triphenyl-2-methylcyclopentane.*" By R. D. Abell.

2-Phenyl-1:3-dimethyl-1:3-dibenzoylpropane, $C_{25}H_{24}O_2$ (*Trans.*, 1901, lxxix., 936), when reduced by zinc dust and acetic acid, yielded the cyclic pinacon 1:3:5-triphenyl-2:4-dimethyl*cyclo*pentandiol, $C_{25}H_{26}O_2$ (prisms, m. p. 143—144°), and this on reduction with red phosphorus and hydriodic acid gave two isomeric 1:3:5-triphenyl-2:4-dimethyl*cyclo*pentanes, $C_{25}H_{26}$, the one crystallising in needles, m. p. 80—81°, the other being a yellow oil (b. p. 246—248°, 25 m.m.).

When fused with oxalic acid, the pinacone loses two molecules of water (Fischer, *Ber.*, 1897, xxx., 559) to form the unsaturated hydrocarbon, 1:3:5-triphenyl-2:4-dimethyl*cyclo*pentadiene, $C_{25}H_{22}$ (needles, m. p. 127—128°), which, on reduction with red phosphorus and hydriodic acid, also gave both saturated hydrocarbons.

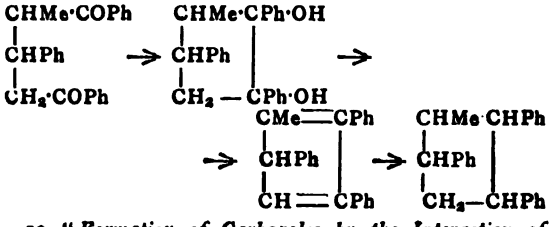


2-Phenyl-1-methyl-1:3 dibenzoylpropane, $C_{24}H_{22}O_2$, on reduction with zinc dust and acetic acid gave (i.) 1:3:5-triphenyl-2-methyl*cyclo*pentandiol, $C_{24}H_{24}O_2$; (ii.) 1:3:5-triphenyl-2-methyl*cyclo*pentadiene, $C_{24}H_{20}$; the former is a brown oil crystallising with difficulty; the latter, which is probably due to the dehydration of the cyclic pinacone by acetic acid, forms yellow needles, and melts at 162—163°.

The cyclic pinacone, $C_{24}H_{24}O_2$, obtained as an almost colourless oil by reducing the 1:5-diketone with sodium amalgam in moist ethereal solution, solidified in needles (m. p. 68—80°) when left in a vacuum over concentrated sulphuric acid, but could not be re-crystallised from solvents as it always separated as an oil.

The cyclic pinacone, when fused with oxalic acid, gave the unsaturated hydrocarbon, 1:3:5-triphenyl-2-methyl-*cyclo*pentadiene, $C_{24}H_{20}$ (yellow needles, m. p. 162—163°).

Both the pinacone and the unsaturated hydrocarbon gave two isomeric 1:3:5-triphenyl-2-methyl*cyclo*-pentanes, $C_{24}H_{20}$, on reduction with red phosphorus and hydriodic acid, the one crystallising in needles (m. p. 121—122°), the other being a yellow oil (b. p. 260—262°, 28 m.m.).



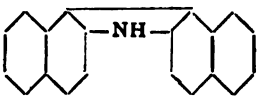
12. "*Formation of Carbazoles by the Interaction of Phenols, in the Orthoketonic Form, with Arylhydrazines.*" By F. R. Japp and W. Maitland.

In a preliminary note (*Proc.*, 1901, xvii., 176) the authors showed that carbazoles could be obtained by heating certain phenols with arylhydrazines in presence

of their hydrochlorides. They now find that the ease with which this reaction occurs is proportional to the readiness with which the phenol in question passes into the tautomeric orthoketonic form. Thus phenol iteelf does not yield any carbazole under the foregoing conditions; α-naphthol reacts, but with great difficulty, giving a very poor yield of the carbazole derivative; β-naphthol and 9-hydroxyphenanthrene react with relative ease. This is precisely the order of reactivity in the orthoketonic form, which Thiele's theory of double linkings would, in its application to benzene derivatives, predict for these phenols.

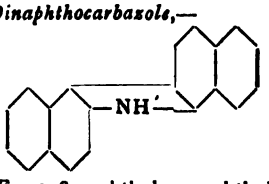
In addition to the carbazoles described in the preliminary note, the following have been prepared. The nomenclature adopted is that proposed by Graebe (Ber., 1894, xxvii., 3066).

2-1 : 2-*Dinaphthocarbazole*,—



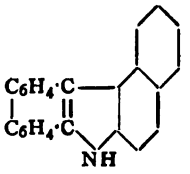
(m. p. 155°).—From β-naphthol, β-naphthylhydrazine and its hydrochloride; identical with "dinaphthyleneamine," which Walder (*Ber.*, 1882, xv., 2173) obtained by heating ββ-dinaphthol with the double compound of zinc chloride and ammonia.

1 : 2 : 2' : 1'-*Dinaphthocarbazole*,—



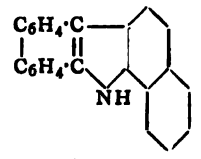
(m. p. 231°).—From β-naphthol, α-naphthylhydrazine and its hydrochloride.

9 : 10-*Phenanthro*-1' : 2'-*naphthocarbazole*,—



(m. p. 220°).—From 9-hydroxyphenanthrene, β-naphthylhydrazine and its hydrochloride.

9 : 10-*Phenanthro*-2' : 1'-*naphthocarbazole*,—

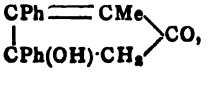


(m. p. 225·5°).—From 9-hydroxyphenanthrene, α-naphthyl, hydrazine, and its hydrochloride.

In their first note an this subject (*loc. cit.*) the authors pointed out that 1 : 2-naphthocarbazole (phenyl-2-naphthylcarbazole), first prepared by Schöpff (*Ber.*, 1896, xxix, 269), melted at 134—135°, instead of, as stated by that investigator, at 120°. They had overlooked the fact that this correction had already been made by F. Ullmann (*Ber.*, 1898, xxxi., 1697).

13. "*Dimorphism of α-Methylanhydracetonebenzil.*" By F. R. Japp and A. C. Michie.

α-Methylanhydracetonebenzil,—



which is best obtained by the condensation of benzil with methyl ethyl ketone under the influence of a 0·5 per cent solution of potassium hydroxide in absolute alcohol, was described by Japp and Meldrum (*Trans.*, 1901, lxxix, 1029) as forming large, flat crystals of rhombic outline ("lozenge-shaped") melting at 118°. These crystals show oblique extinction in polarised light.

The authors prepared this compound on various occasions, and were able to confirm the foregoing observations. About a year ago, however, although working under apparently the same conditions, they obtained a substance crystallising in octahedra which were isotropic in polarised light, and melted at 133·5°. Analysis showed that this substance had the same composition as α-methylanhydracetonebenzil.

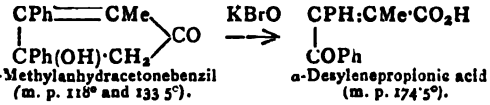
Further investigation has demonstrated that these two substances, which the authors at first supposed to be distinct chemical compounds, are, in reality, merely dimorphous forms of α-methylanhydracetonebenzil. The difficulty in proving this lay in the fact that, after the second form had once been obtained, it was apparently impossible again to prepare the first form. At last, however, the authors succeeded in doing this, but they were quite unable to obtain the result a second time; moreover, the substance was so unstable that it was converted, even in determining its melting-point, into the less fusible form.

The authors wish to call attention to this dimorphism, as other investigators, who might happen to obtain the more stable form first, would probably fail to recognise the substance as chemically identical with that formerly described (*Trans.*, *ibid.*).

14. "*The Oxidation Products of the Methyl Homologues of Anhydracetonebenzil.*" By F. R. Japp and A. C. Michie.

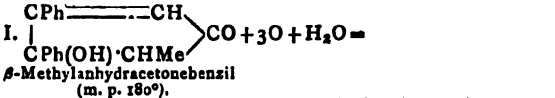
The various methyl homologues of anhydracetonebenzil were described by Japp and Meldrum (*Trans.*, 1901, lxxix, 1028, 1036, and 1037). The present authors have studied the oxidation of these substances, with the exception of αββ-trimethylanhydracetonebenzil, which, owing to the difficulty of preparing it, was not included in the investigation.

Of the four methyl homologues examined, only α-methylanhydracetonebenzil is attacked by alkaline hypobromite:—

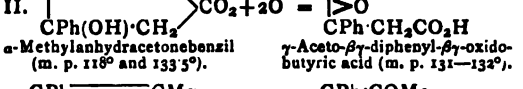


α-Methylanhydracetonebenzil (m. p. 118° and 133·5°). α-Desyleneproplonic acid (m. p. 174·5°).

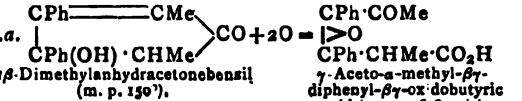
All four homologues are, however, readily oxidised by chromium trioxide in acetic acid solution:—



β-Methylanhydracetonebenzil (m. p. 180°). α-Methyl-α'β-diphenyl-α'β-dihydroxyglutaric acid (m. p. 176°, with decomposition).



α-Methylanhydracetonebenzil (m. p. 118° and 133·5°). γ-Aceto-βγ-diphenyl-βγ-oxidobutyric acid (m. p. 131—132°).



αβ-Dimethylanhydracetonebenzil (m. p. 150°). γ-Aceto-α-methyl-βγ-diphenyl-βγ-oxidobutyric acid (m. p. 164°, with decomposition).

III.*b*. $CPh{=}CMe$ / $CPh(OH)\cdot CHMe$ $>CO + O + H_2O =$

αβ-Dimethylanhydracetonebenzil.

$= CPh(OH)\cdot CMe(OH)$ / $CPh(OH)—CHMe >CO$

1 : 3-Dimethyl-4 : 5-diphenyl-1 : 4 : 5-trihydroxycyclopentanone-(2) (m. p. 89°).

IV. $CPh{=}CH$ / $CPh(OH)\cdot CMe_2 >CO + 3O =$ $CPh\cdot CO_2H$ / $>O$ / $CPh\cdot CMe_2\cdot CO_2H$

ββ-Dimethylanhydracetonebenzil (m. p. 181°).

αα-Dimethyl-*α'β*-diphenyl-*α'β*-oxidoglutaric acid (m. p. 171° and 184°).

The authors suggest the use of the prefix "oxido" to denote "bridge-oxygen" regarded as a bivalent substituent.

15. "*Action of Hypobromites on Amides.*" By A. Lapworth and W. W. S. Nicholls.

The action of hypobromites on certain amides has been carefully studied with the idea that the change might depend on the formation, at an intermediate stage, of alkyl and cyanate ions, which would subsequently unite to form an alkyl carbimide, as indicated in the following equations:—

$$CH_3\cdot CO\cdot NH_2 + Br_2 = \overset{+}{C}H_3 + \overset{-}{C}NO + 2HBr,$$

$$\overset{+}{C}H_3 + \overset{-}{C}NO = CH_3\cdot N{:}C{:}O.$$

In endeavouring to imitate the conditions supposed to obtain during the reaction, potassium cyanate was warmed with potassium methyl sulphate in alkaline solution; methylamine was easily isolated, but in comparatively small amount. It is well known that phenylcarbimide is formed when nascent phenyl groups (ions?) are produced in presence of potassium cyanate, as when benzenediazonium salts are decomposed by copper powder.

An examination was made of the by-products in the preparation of methylamine from acetamide and of aniline from benzamide, particular attention being paid to the possibility of methyl alcohol and phenol or their decomposition products being formed, but no direct evidence bearing on the point was obtained. From benzamide, under these conditions, benzylidenedibenzamide, $CHPh(NHCOPh)_2$, is almost invariably obtained. This is probably not produced from benzaldehyde formed at an intermediate stage, as the aldehyde does not condense with benzamide under the experimental conditions.

16. "*Derivatives of Menthyl Cyanoacetate.*" By D. A. Bowack and A. Lapworth.

A recent abstract (1903, lxxxiv., ii., 2) of a paper by Tschugaeff (*J. Russ. Phys. Chem. Soc.*, 1902, xxxiv., 606—622) contains a reference to the optical rotation of menthyl cyanoacetate. As the authors have had this compound and some of its derivatives under examination for several months, they wish to record certain of their observations.

Menthyl cyanoacetate, $CN\cdot CH_2\cdot CO_2\cdot C_{10}H_{19}$, prepared by heating the ethyl ester with menthol, crystallises in well-formed, flattened needles melting at 83—84°. In 2 per cent solution in benzene, it had $[\alpha]_D = -81{\cdot}12°$ (Tschugaeff gives $-87{\cdot}71°$) and no mutarotation could be detected. The *monobromo*-derivative, $CN\cdot CHBr\cdot CO_2\cdot C_{10}H_{19}$, crystallises in long needles, and melts at 134—135°.

Menthyl p-*tolylazocyanoacetate*,—

$$C_6H_4Me\cdot N_2\cdot CH(CN)\cdot CO_2\cdot C_{10}H_{19},$$

crystallises in large, transparent, yellow plates melting at 93—95°; it has $[\alpha]_D = -53{\cdot}7°$ in benzene, and does not exhibit mutarotation.

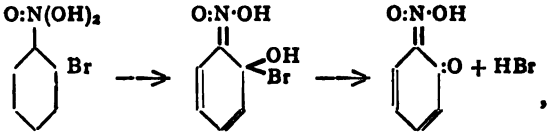
Menthyl p-*bromophenylanocyanoacetate*,—

$$C_6H_4Br\cdot N_2\cdot CH(CN)\cdot CO_2\cdot C_{10}H_{19},$$

has been obtained in two forms, one crystallising in transparent plates melting at 97—98°, and the other in slender needles having a somewhat indefinite melting-point.

17. "*The Influence of Nitro-groups on the Reactivity of Halogen Derivatives of Benzene.*" By A. Lapworth.

Four years ago, the reactivity of the halogen atoms in the *ortho*- and *para*-halogenated nitrobenzenes was discussed on the assumption that an addition product, formed by adding the elements of water or another agent to the nitro-group, underwent change in the following way:—



this reaction being impossible when the halogen is in the *meta*-position (Lapworth and Mills, *Proc.*, 1898, xiv., 159).

This explanation, which was put forward at a time when the part played by quinonoid intermediate compounds in conditioning analogous changes was not generally recognised, is revived because other reactions of this type are now being explained on similar lines.

Ordinary Meeting, Thursday, February 5th, 1903.

Dr. E. Divers, F.R.S., Vice-President, in the Chair.

Mr. W. Carter-White was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Arthur William Eastwood, B.A., Newton College, S. Devon; John Percy Edgerton, 39, White Hart Lane, Barnes, S.W.; George Howsam, School of Science, Peterborough; Alfred Owen Jones, 18, Queen's Gardens, Tetherdown, Muswell Hill; James Stewart Kerr, The Grove, Ladywood Road, Birmingham; George Siddle, Middleton-One-Row, R.S.O.; William Francis John Wood, B.Sc., Doncaster Road, Barnsley; Edward Chancey Worden, Millburn, New Jersey, U.S.A.

Of the following papers, those marked * were read:—

*18. "*The Solubilities and Transition points of Lithium Nitrate and its Hydrates.*" By F. G. Donnan and B. C. Burt.

Lithium nitrate was found to yield two hydrates, $LiNO_3{,}3H_2O$ and $LiNO_3{,}\frac{1}{2}H_2O$. Of these the former has been obtained previously by Dott, who showed it to be the trihydrate and not $LiNO_3{,}2\frac{1}{2}H_2O$ as stated by Kremers and by Troost. Determinations of the solubility of these hydrates, and also of the anhydrous salt, were carried out, and in this way the various quadruple points of the system located, the position of these points being also confirmed by thermometric and dilatometric measurements. The trihydrate is of special interest as it possesses a stable melting-point. The equilibrium curve in the neighbourhood of this point was fully investigated.

The following is a list of the melting-points and quadruple points of the system:—

Cryohydrate point of $LiNO_3{,}3H_2O$, $-17{\cdot}8°$.

Melting-point of $LiNO_3{,}3H_2O$, 29·88°.

Transition point, trihydrate + semihydrate $\rightleftarrows$ saturated solution, 29·6°.

Transition point, semihydrate $\rightleftarrows$ anhydrous salt + saturated solution, 61·1°.

*19. "*The Synthesis of αα-Diglutaric Acid.*" By O. Silberrad and T. H. Easterfield.

The action of iodine on the sodium derivative of ethyl α-carboxyglutarate does not lead to the formation of the hexa-ethyl ester,—

$$CO_2Et\cdot CH_2\cdot CH_2\cdot C(CO_2Et)_2\cdot C(CO_2Et)_2\cdot CH_2\cdot CH_2\cdot CO_2Et,$$

from which *aa*-diglutaric acid could be obtained by successive hydrolysis and loss of carbon dioxide, but gives rise to the hitherto unknown *ethyl α-sodo-α-carboxyglutarate* (*ethyl α-iodobutane-aαγ-tricarboxylate*), the reaction taking place in accordance with the following equation:—

$$CO_2Et{\cdot}CH_2{\cdot}CH_2{\cdot}CNa(CO_2Et)_2 + I_2 = CO_2Et{\cdot}CH_2{\cdot}CH_2{\cdot}CI(CO_2Et)_2 + NaI.$$

Bromine behaves similarly, yielding *ethyl α-bromo-α-carboxyglutarate* (*ethyl α bromobutane-aαγ-tricarboxylate*) (sp. gr. 1·325 at 15°/4°).

Again, on heating the sodium derivative with these halogenated esters, no condensation occurred, but instead a mixture of alkyl carboxyglutarate and a new ethyl carboxyglutaconate (b. p. 173—176°) under 15 m.m. pressure) was produced, the latter differing from its isomeride (ethyl *iso*aconitate) in that it does not contain a mobile hydrogen atom, and can therefore neither assume the enolic form nor yield a sodium derivative.

As the preceding method failed to give rise to the desired ester, its synthesis was next tried by one of the authors (O. S.) in the manner represented by the following equation:—

$$\begin{array}{l} CO_2Et{\cdot}CH_2{\cdot}CH_2I \quad NaC(CO_2Et)_2 \\ \qquad\qquad + \qquad\quad | \quad = \\ CO_2Et{\cdot}CH_2{\cdot}CH_2I \quad NaC(CO_2Et)_2 \end{array}$$

$$\begin{array}{l} \qquad\qquad\qquad\qquad\qquad\quad CO_2Et{\cdot}C_2H_4{\cdot}C(CO_2Et)_2 \\ = 2NaI + \qquad\qquad\qquad\qquad\quad | \\ \qquad\qquad\qquad\qquad\qquad\quad CO_2Et{\cdot}C_2H_4{\cdot}C(CO_2Et)_2 \end{array}.$$

This process proved successful, and yielded ethyl *aa*-di-*α*-carboxyglutarate (isolated as *aa*-diglutaric acid) together with ethyl $\Delta^{\alpha\beta}$-*α*-di-hydromuconate (?), ethylbutane-$a\gamma\gamma\delta\delta$-pentacarboxylate (b. p. 215—218°) under 17 m.m. pressure), which, on saponification, yielded butane-$a\gamma\delta$-tricarboxylic acid (m. p. 122°), and ethyl ethylenetetracarboxylate.

A fractionator was described for distilling under greatly diminished pressure; this apparatus was designed in order to overcome the difficulty due to the variation of pressure caused by throttling, which is experienced under these conditions when the ordinary columns are employed.

20. "*Distillation of Chlorine Water.*" By A. Richardson.

Pickering (*Trans.*, 1870, xxxvii., 139) has shown that, when aqueous solutions of chlorine are heated in an open vessel, a residue containing hydrochloric acid remains behind after all the active chlorine has been expelled, and the present work was undertaken in order to find out whether the escaping chlorine was present wholly in a free state or mixed with one of its oxy-acids.

When chlorine water was heated in a retort, the distillate, which was obtained below 100°, contained free chlorine, the gas being readily displaced by a current of air; the solution in the retort, however, still contained active chlorine, for it liberated iodine from potassium iodide, bleached indigo solution immediately, and gave, on shaking with mercury, a brownish-yellow deposit resembling that obtained with hypochlorous acid. This result proved to be independent of the action of light, and was not influenced by further purification of the chlorine.

Quantitative estimations of the chlorine in the aspirated distillate gave, for the active chlorine estimated iodometrically, values double those obtained for the total chlorine found with silver nitrate after treatment with sulphur dioxide. These results show that the active chlorine is present as hypochlorous acid.

Distillation of chlorine water in a current of chlorine gas showed that the hydrochloric acid formed in the residual solution was equivalent to the hypochlorous acid found in the distillate, indicating that a portion of the chlorine reacts with the water according to the equation $Cl_2 + H_2O = HCl + HClO$.

Again, when aliquot parts of the distillate and residue obtained on distilling chlorine water were mixed, a solution having all the properties of the original chlorine water was reproduced. It would appear, therefore, that hydrochloric and hypochlorous acids are separated during distillation as the products of the partial change of chlorine water.

When chlorine water was heated in a flask provided with a reflux condenser, so that the distillate returned to the original solution, the ratio of active to total chlorine found was that required for a solution of free chlorine, showing that the solution is stable when the separation of the two acids is prevented.

A further study of the change showed that the amount of hypochlorous acid passing over decreased with the increase in strength of the hydrochloric acid formed in the solution. With very dilute solutions of chlorine water, the whole of the free halogen employed entered into reaction with the solvent, the oxy-acid only having been found in the distillate.

Finally, distillation of very dilute chlorine water in a vacuum at the ordinary temperature gave a distillate containing the oxy-acid, showing that the reaction occurs at the ordinary temperature as well as at the boiling-point.

21. "*A New Vapour Density Apparatus.*" By John S. Lumsden.

This apparatus is based on the principle that the molecular weights of all substances in the state of gas, when occupying the same volume and at the same temperature, exert the same pressure. The pressure produced at a given temperature by the molecular weight in milligrms. is either found experimentally by vaporising a substance of known molecular weight or calculated from the dimensions of the apparatus; then, from the pressure produced by vaporising a weighed quantity of the substance the molecular weight of which is required, the weight in milligrms. which would produce the milligrm. molecular pressure is found. This is taken as the molecular weight.

No barometric reading is necessary, and when the constant of the apparatus has been found and the substance weighed, the experiment is completed in two minutes, and the calculation of the result may be made in another two minutes.

By slightly modifying the arrangement of the apparatus, the substance may be vaporised under diminished pressure or in an inert gas, and the experiment may be performed at any temperature. The instrument, which is quite as accurate as the Victor Meyer apparatus, is, owing to its simplicity, well adapted for general laboratory work.

22. "*A New Form of Pyrometer.*" By John S. Lumsden.

A constant volume instrument was described in which a weighed quantity of a substance is vaporised and the pressure measured by a mercury gauge.

The pressures produced by equal weights of substance are proportional to the absolute temperatures; therefore, if at two temperatures the pressures produced by equal weights are measured and one temperature is known, the other can be calculated.

The instrument may be made of glass, porcelain, or metal, and high temperatures may be measured within a few degrees.

23. "*Tertiary Butylphenol.*" By E. W. Lewis.

The author draws attention to the non-formation of phenyl-*tsr.*-butyl ether on digesting phenol in alcoholic solution with *tsr.*-butylchloride and excess of alkali, and to the production in these circumstances of the isomeric *tsr.*-butylphenol. Other instances of the difficulty attending the preparation of phenol ethers containing a tertiary radicle in place of the hydrogen of the phenolic hydroxyl group are cited in the paper.

Anniversary Dinner.

It has been decided by the Council to arrange for a Dinner of the Fellows of the Society and their friends on Wednesday, March 25th, 1903, this being the day fixed for the Annual General Meeting. Further particulars will be announced shortly.

ROYAL SOCIETY OF NEW SOUTH WALES.

The General Monthly Meeting of the Society was held at the Society's House, No. 5, Elizabeth Street North, on Wednesday evening, December 3, 1902; Prof. Warren, M.Inst.C.E., Wh.Sc., President, in the Chair.

The following paper was read:—

"*On the presence of Platinum and Iridium Metals in Meteorites.*" By Professor Liversidge, LL.D., F.R.S.

At the September meeting of the Society the author described the occurrence of gold in meteorites. In certain cases the gold is accompanied by one or more of the platinum and iridium metals. The Boogaldi meteorite contains both gold and one or more of the platinum metals; these metals do not appear to be uniformly diffused through the meteorite, for some parts apparently contain a much larger proportion than others. The meteoric iron was dissolved in hydrochloric acid, the usual black carbonaceous residue was then ignited and afterwards ground in an agate mortar. On washing off the lighter powder the metals are seen as lustrous yellow and silvery spangles; by means of a needle these can for the most part be picked up and separated. The first few white metallic spangles obtained were insoluble in a mixture of nitric and hydrochloric acids when warmed and evaporated to dryness on a microscope slide (the tests were at first applied under the microscope), and it looked as if the white spangles consisted solely of iridium metals insoluble in nitro-hydrochloric acid, but afterwards it was found that another portion of the meteorite yielded a larger quantity of them, and this—treated with a larger volume of aqua regia—dissolved. Both gold and platinum were separated from the solution by the usual wet methods; iridium and other metals of this group are probably present. The amount of the platinum metals in the Boogaldi meteorite is comparatively large, being at the rate of several ounces per ton; details will be found in the paper.

The Action of Bromacetic Ether on Nitrite of Silver.—Roland Scholl and Alwin Schofer.—The authors have carried out this reaction on a large quantity of matter (1275 grms. of bromacetic ether and 1815 grms. of nitrite of silver) so as to be able to isolate all the products. They were not able to obtain any nitroacetate of ethyl, but they were enabled to characterise the following products:—Glycolate of ethyl, ethyl-glycolate of ethyl, nitrate and nitrite of glycolic ether, oxalate of ethyl, anhydronitroacetate of ethyl, bisanhydronitroacetate of ethyl, and, finally, a compound with the formula $C_{12}H_{15}NO_8$. The three last products are new. *Anhydronitroacetate of ethyl*, $CO_2C_2H_5—C{\equiv}N{=}O$, crystallises from boiling benzene in colourless needles fusible at 111—111·5°, soluble in acetic acid, ether, and chloroform, slightly soluble in water and alcohol, almost insoluble in cold C_6H_6, CS_2 and ligroin. The bisanhydronitroacetate of ethyl, $\begin{matrix} CO_2C_2H_5—C{=}N{=}O \\ \quad\quad\quad\quad\quad\quad | \quad\quad | \\ O{=}N{=}C—CO_2C_2H_5 \end{matrix}$, is an oil with a slight odour, boiling at 160° under 11 m.m., and at 233—234° at the ordinary pressure, with slight decomposition; the reduction of this ether results in glycocol; the potassium salt of the corresponding acid crystallises with $3H_2O$; when treated with HCl it gives the free acid in needles, fairly soluble in water and alcohol, slightly soluble in ether; it is very unstable and explosive. The amide decomposes at 120—121°, the methylamide fuses at 162°, the benzylamide at 174—175°, the allylamide at 95—97°, the diethylamide decomposes at 167°. The compound $C_{12}H_{15}NO_8$ is a yellowish oil boiling at 188—190° under 11 m.m.; it is probably the ether of a tricarbonic acid, $C_3O_2N(CO_2H)_3$; with ammonia it gives a white powder which should be the corresponding triamide; the figures of the analysis of this latter body do not agree very well with theory.—*Berichte*, vol. xxxiv., p. 870.

NOTICES OF BOOKS.

General Index to the First Twenty Volumes of the Journal of the American Chemical Society, 1877-1898. Easton, Pennsylvania. 1902. Pp. 237. 8vo.

This valuable contribution to chemical bibliography has been prepared under the supervision of two gentlemen who modestly sign only their initials to the explanatory preface, but who are recognised thereby as Professors Edward W. Morley and Olin F. Tower, both of Adelbert College, Cleveland, Ohio. The volume comprises an author and a subject-index, besides indexes to new books reviewed in the journal, and to obituaries. The whole seems to be carefully prepared, the original cards having been twice verified; few liberties have been taken with titles except in spelling uniformly certain words. The work includes not only the "Journal" of the Society, but the earlier publication known as "Proceedings," issued in two volumes in 1877-79.

The thanks of all chemists, as well as of librarians, are due for this laborious undertaking, which has been a labour of love on the part of the gentlemen named.

Twelfth Census of the United States. Manufactures, Chemicals and Allied Products. Census Bulletin, No. 210, Washington, D.C. 1902. Pp. 306. 4to.

The subject of chemicals and their manufacture was included in the tenth census, and also in the eleventh, but the attempts made in those years bear little resemblance to the thorough, comprehensive, and well arranged matter in the volume under review. The government officials in charge of the twelfth census were fortunate enough to secure the services of a most able chemist to take the direction of the arduous task, Professor Charles E. Munroe, Ph.D., of the Columbian University, Washington, D.C., and a Past President of the American Chemical Society, who is known as authority on high explosives. Associated with him was the painstaking, indefatigible Dr. Thomas M. Chatard.

Their voluminous report gives statistics, in several distinct tables, of fertilisers, dye-stuffs and tanning materials, paints, varnishes, explosives, essential oils, chemicals, bone, ivory, and lamp-black, all arranged by States; preceding these tables is an admirable summary of the growth of chemical industry in the United States This summary shows wide reading and intelligent compilation, with short bibliographies at the end of each section. The number of active establishments reported is 1827; owing to the hearty co-operation of the managers of these works the statistics and information have been made unusually full and accurate.

In an appendix of 146 pages is given a digest of United States patents, arranged under nineteen heads, and of great value to inventors. Each item contains the number and date of the patent, the name of the claimant, and a synopsis of the claim.

The chief statistician for manufactures, S. N. D. North, in transmitting Professor Munroe's report to the Director of the Census, characterises it as "exhaustive and valuable," and adds:—"Nothing approaching it in any particular has ever before been presented at any census of the United States."

The voluminous Bulletin lacks a table of contents, and of course an index under the circumstances cannot be expected; nevertheless, it will long be an authoritative and satisfactory source of information on the subject of chemical manufactures in the United States at the close of the nineteenth century. H.C.B.

A Course in Botany and Pharmacognosy. By Henry Kraemer, Ph.B., Ph.D. Illustrated with Plates from Original Drawings by the Author. Philadelphia: Press of Edward Stern and Co. 1902. Pp. 384.

The material used in compiling this volume has been furnished largely by medicinal plants and the commercial

vegetable drugs. Although certain mineral drugs are used largely, there can be no doubt that vegetable remedies are the more natural ones, and are far better suited to mankind, as a rule, than such materials as calomel, sulphate of magnesia, arsenic, &c.

The subject of morphology has been more or less extensively treated by the author, particularly that of the plant cell, because this knowledge is of fundamental importance in the study of vegetable drugs.

The book is divided into four parts, on plant morphology, pharmacognosy, reagents, and illustrations respectively.

Part I. consists of two chapters; the first is on the cell, and deals with cell-contents, both organised, such as protoplasm, plastids, &c., and unorganised, like starch, sugars, alkaloids, mucilages, oils, and colouring principles. The origin and composition of cell-walls, and the forms of cells are described in Sections D and E of this chapter. Chapter II. is on the vegetative and re-productive parts of the plant, the vegetative section dealing with the roots, stem, and leaves, while Section B is devoted to the flower and its functions.

Part II., on Pharmacognosy, is divided into two chapters, viz., Chapter I, "Crude Vegetable Drugs," and Chapter 2, "Powdered Vegetable Drugs"; this part fills the bulk of the book, covering 213 pages. Pharmacognosy means a knowledge of drugs, and it is usually limited to the study of drugs of a vegetable origin; in these pages a large number of drugs are described *seriatim*, their constituents, appearance, allied plants, and probable adulterants being given in most cases.

On page 266 and following, there is a key for the study of powdered drugs, which will be found of great assistance; in the remaining portion of the chapter each of these powders is dealt with specifically at greater length. There are seventeen plates of illustrations which merit close attention, and a good index of 52 columns.

Subject-list of Works on General Science, Physics, Sound, Music, Light, Microscopy, and Philosophical Instruments in the Library of the Patent Office. London: Darling and Son, Ltd., and the Patent Office. 1903. Pp. 183.

This subject-list, No. 11 of the Patent Office Series, consists of two parts:—(*a*) A general alphabet of subject headings, with entries in chronological order of the works arranged under these headings; (*b*) a key or summary of these headings shown in class order.

It is recommended that these lists be used strictly as subject guides and not for the purpose of tracing a work by its title, as the contents of the work have been considered in making an entry in preference to the language of the title-page, which is often misleading.

The present list comprises 1849 works, representing 9281 volumes; the catalogue entries relating to these works number 2069, and are distributed under 196 headings and sub-headings.

A History of Hindu Chemistry; from the Earliest Times to the Middle of the Sixteenth Century, A.D.; with Sanskrit Texts, Variants, Translation, and Illustrations. By Praphulla Chandra Ray, D.Sc., Professor of Chemistry, Presidency College, Calcutta. Vol. I. London: Williams and Norgate. 1902. Pp. 217.

Chemistry among the ancients has always been closely allied with medicine, metallurgy, and the transmutation of metals. In India, more than in Europe, chemistry has been evolved principally in connection with medicine, but it was always backed up, so to speak, with an appeal to the gods, and the higher gods of the *Rigveda* are almost entirely personifications of the elements and the other natural phenomena, such as fire, wind, the sun, and the dawn.

The earliest literary record of Indian medicine, the "*Atharva-veda*," deals chiefly with sorcery, witchcraft, and demonology. In the "*Ayurvedic*" period the Hindu system of medicine was arranged on a rational basis, with a scientific terminology; the two great works of this period are the "Charaka" and the "Susruta," in which the subject is found to have made a distinct advance. Then followed the "transitional" period, the "Iantric period," and the "Tatro-chemical" period.

The first or "Ayurvedic" period was from the pre-Buddhistic Era to about 800 A.D.; the transitional period is from 800 A.D. to about 1100 A.D.; while the last two are from 1100 to 1300 A.D. and 1300 to 1550 A.D. respectively.

The book is of interest, inasmuch as it shows the considerable amount of knowledge possessed by the Hindus. Their knowledge was principally rule-of-thumb work, which gave them very fair practical results.

Elektromagnetische Aufbereitung ("Electromagnetic Dressing"). By F. Langguth. Halle-a-S.: Wilhelm Knapp. 1903.

This volume forms a part of the new "Handbuch der Elektrochemie," the issue of which has recently commenced, and is complete in itself, the subject treated of being capable of being comprised in one moderate sized volume. The principle of electromagnetic dressing of ores is explained, and the most important kinds of ore-separations are described with considerable attention to detail, the latest developments in this respect being as far as possible included. Valuable statistics dealing with the results of the various magnetic separation processes conclude the volume, which gives an adequate account of the essentials of the subject.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 4, January 26, 1903.

Researches on the Alkaloids of Quinquina: Cinchonine, Cinchonidine, and Cinchonamine.—MM. Berthelot and Gaudechon.—The authors continue their researches on the alkaloids of quinquina, and find the thermal constants of cinchonine, cinchonidine, and cinchonamine.

Nickel Steel.—Léon Guillet.—The addition of nickel to steel lowers the magnetic transformation point of the steel. The author examines with a microscope three series of very pure steels containing only traces of phosphorus, silicon, sulphur, and manganese. He finds that until the steel contains 7 per cent of nickel the structure is identical with that of ordinary steel containing carbon. When, however, the proportion of nickel attains 10 per cent, the micro-structure changes completely, white crystals appear on the surface; and when 25 per cent of nickel is present, these crystals are very numerous.

The Existence of Electrolytic Superoxides of Lead, Nickel, and Bismuth.—A. Hollard.—It has always been admitted that the lead peroxide which is deposited at the anode of a saline lead solution through which a current passes is lead dioxide, PbO_2. Contrary to this assertion, the author finds—(1) That the analytic factor, 0·866, is too great, and that, in addition to the dioxide PbO_2, higher oxides are deposited at the anode; (2) that the proportion of these higher oxides is greater as the concentration of the lead in the bath is decreased. Nickel and bismuth also form similar oxides when their solutions are subjected to electrolysis.

Equilibrium produced between Copper, Silicon, and Manganese. Manganese Silicide, Si_2Mn.—P. Lebeau.—An investigation of the action of a great number of metals on copper silicide leads the author to the conclusion that certain of them, such as silver, tin, zinc, and aluminium, have a real affinity for copper, forming an alloy with this metal, and causing the silicon to crystallise out. Other metals, on the contrary, react on molten copper silicide, uniting with the silicon to form a definite silicide, and giving at the same time compounds with silicon and copper. To investigate the equilibrium of these systems, the author prepares a series of metallic masses containing copper, silicon, and another metal in definite proportions. The experiments led to the preparation of three definite silicides of manganese—$SiMn_2$, SiMn, and Si_2Mn.

Two Phosphorus Acids derived from Methylethylketone.—C. Marie.—Methylethylketone when acted upon by H_3PO_2 does not give the diketonic acid corresponding to dioxyisopropylhypophosphorous acid. The monoketonic acid, $PO_2H_3CH_3COC_2H_5$, is obtained, and, by oxidation, the oxyphosphinic acid, $PO_3H_3CH_3COC_2H_5$. These two acids constitute the superior homologues of the oxyisopropylhyperphosphorous and oxyisopropylphosphinic acids, which the author has already described.

A New Di-iodated Phenol.—P. Brenans.—In a previous research the author investigated the di-iodated derivatives of phenol, $OH-C_6H_3-I_2$-(1.2.4), (1.2.6), and (1.3.6). He now discusses a fourth isomer, di-iodated phenol, $OH-C_6H_3-I_2$-(1.3.5), which he obtains from di-iodated orthonitraniline, $C_6H_2-NH_2-NO_2-I_2$-(1.2.4.6), by the following succession of reactions:—(1) The diazoic derivative of the latter substance, when decomposed by absolute alcohol, gives the di-iodated nitrobenzene, $C_6H_3-NO_2-I_2$ (1.3.5); (2) the base resulting from the reduction of this nitro-di-iodo benzene, di-iodated aniline, $C_6H_3-NH_2-I_2$-(1.3.5), is subjected to diazotisation; and (3) finally, the diazoic salt, when heated in the presence of water, gives di-iodophenol, $OH-C_6H_3-I_2$-(1.3.5).

Rotatory Power in the Homologous Ethers of Borneol, Isoborneol, and Camphocarbonic Acid.—J. Minguin and G. de Bollemont.—The rotatory power of the bornylic ethers is measured in the case of bornyl stearate, oleate, crotonate, and cinnamate. Also that of the isobornylic ethers, isobornyl formate, acetate, propionate, isobutyrate, butyrate, valerianate, laurate, and the camphocarbonic ethers, camphocarbonate of methyl, ethyl, propyl, isobutyl, and allyl.

Chloruration of Substituted Aromatic Carbides by Ammoniacal Lead Chloride.—A. Seyewetz and P. Trawitz.—Monochlorated benzene is only very slowly attacked at boiling-point or in sealed tubes at about 210°, when acted upon by plumbo-ammoniacal chloride. Bromated and iodated benzene give chlorobromo- and chloroiodo-derivatives. With the homologues of benzene already chlorated in the aromatic radicle, there is no new substitution in this radicle, but only in the lateral chain. In the aromatic carbides having a lateral chain, substitution only takes place in this chain by a halogen; the substitution continues without the aromatic radicle being attacked. The presence of nitrated groups hinders chloruration by plumbo-ammoniacal chloride.

Researches on $\alpha\beta$-Dimethylglutaric Acids.—E. E. Blaise.—The author's researches on the $\alpha\beta$-dimethylglutaric acids show that the acid, $C_7H_{12}O_4$, obtained from ethyl bromopivalate, is different from one at least of the predicted $\alpha\beta$ dimethylglutaric acids.

Preparation and Properties of Hexanediol-1.6, or Hexamethylenic Glycol and its principal Derivatives.—J. Hamonet.—In preparing hexamethylenic glycol, the author first transforms diphenoxyhexane into the di-iodated hexane, then into diacetone, and finally saponifies this latter substance.

Bulletin de la Société Chimique de Paris.
Series 3, Vol. xxvii., No. 13.

Preparation and Properties of Sulphammonium.—H. Moissan.—Already noticed.

Some Properties of Lime at its Fusing-point.—H. Moissan.—Already noticed.

Research on the Constitution of Compounds of Chromium.—G. Wyrouboff.—The author gives a list of thirty-one double oxalates recently obtained by him. Of these thirty-one compounds, twelve are aluminoxalates, nine are chromoxalates, and the remaining ten are ferrioxalates. The question arises—What is the exact nature of these bodies? All that is known for certain is that they are abnormal or "complex," as their elements cannot be detected in their ordinary reagents, and they do not contain water of constitution. With a view to elucidating this problem, the author has made a number of experiments with oxalate of chromium, $Cr_2O_3,3C_2O_3,25H_2O$. The first fact learnt is that oxalate of chromium, produced under particular conditions, is a crystallisable salt, comparable with all the violet salts of chromium; it is unstable, and is transformed by dehydration into another violet compound which is uncrystallisable. The second fact is that the violet sulphate of chromium can be transformed, under certain conditions, exactly the opposite to the last salt, into an abnormal compound, while still retaining its violet colour.

Crystallographic Constants of the Bromised Derivatives of Benzylidene-camphor and Benzylcamphor.—J. Minguin.—A number of crystallographic observations of the above derivatives are given, but it is remarked that in no cases have hemihedric facets been observed, although the internal structure of the crystals is dissymmetric.

Crystallographic Determination of Methylcamphocarbonate of Methyl and Methylcamphocarbonate of Ethyl, of the Methylic Ether of the Camphoric Mononitrite, and of its Isomer, Methylcamphorimide.—J. Minguin.—Methylcamphorimide is distinguished by its crystallographic characteristics from the methylic ether of the camphoric mononitrite.

Contribution to the Study of the Borneols and their Ethers. Their Crystallographic Examination. The Crystallographic Examination of the Bornylates of Chloral and of Bromal.—J. Minguin.—A long paper, unsuitable for abstraction.

Some Derivatives of the Thio-cresols.—Ch. Rabaut.—The para-thio-cresols were obtained from sulphocyanate of paracresyl, $C_8H_7NS=CH_3.C_6H_4.SCH$, which, in its turn, was prepared from paratoluidine by Sandmeyer's reaction. The sulphocyanate of paracresyl, treated with an alcoholic solution of sulphydrate of potassium, or by zinc and hydrochloric acid, gives thio-paracresol. With acetate of lead, thio-paracresol gives a precipitate, yellow when cold and red when heated. This precipitate can be transformed very easily. By dry distillation it gives $PbS+(CH_3.C_6H_4)_2S$; when treated with bromine in acetic solution, we obtain $(CH_3C_6H_4)_2S_2$; with chloride of acetyl, it gives the acetic ether of thio-paracresol. A mixture of equal molecules of sulphocyanate of paracresyl and monochloracetic acid, heated to boiling, gives off large quantities of hydrochloric acid, and, on cooling, gives a black mass slightly soluble in water. Treated with a dilute boiling solution of soda, and, when cool, with hydrochloric acid, this mass gives a crystalline precipitate, $C_9H_{10}O_2S$.

Production of Sulphuretted Hydrogen during Alcoholic Fermentation.—M. and E. Pozzi-Escot.—(See p. 87).

The Basic Products of the Hydrolysis of Muscle.—M. Etard.—It is proved that, by hydrolysis, alimentary flesh gives a large quantity of alkaloids; it is not to be doubted that digestive hydrolysis does the same, the more

so that if they are of a diastasic nature, they are also microbic.

The Solubility of Prussian-blue under certain conditions.—Ch. Coffignier.—The presence of alcohols of the fatty series greatly facilitates the solvent action of hydrochloric acid. The author gives the results obtained with the principal alcohols, using hot mixtures of equal volumes of hydrochloric acid and the alcohol. Ethylic alcohol gives a solution which soon deposits the prussian-blue, but the other alcohols give solutions which could be kept for several weeks without alteration.

The Order in which the Usual Manipulations should be made in the Diagnostic Analysis of Urines.—Henri Taffe.—Unsuitable for abstraction.

Detection of Salicylic Acid in Foods by the Coloured Reaction of the Ferric Salts.—Henri Taffe.—The author recommends as a solvent-extractor, a mixture of equal parts of ethylic ether and petrol-ether, or better still, as the result of more recent experiments, petrol-ether alone of a density = 0·700. It has a further advantage of not dissolving hydrochloric acid easily, and as is known, free mineral acids in excess diminish the intensity of the colouration of the ferric salicylate, and consequently the sensitiveness of the test.

No. 14.

Action of Hydrochloric, Hydrobromic, and Hydrofluoric Acids on Monopersulphuric Acid.—E. Wedekind. — During the preparation of Caro's reagent, $SO_2 \begin{matrix} O-OH \\ OH \end{matrix}$, by mixing sulphuric acid with ordinary peroxide of hydrogen which contains a certain quantity of hydrochloric acid, we often observe the odour of chlorine very distinctly, which can only result from the oxidation of the hydrochloric acid. By means of M. Baeyer's dry reagent, obtained by the action of concentrated sulphuric acid on persulphate of potassium, we can oxidise hydrochloric acid in the cold, and thus obtain chlorine. A concentrated solution of hydrobromic acid behaves in a similar manner, giving off bromine fumes. With the hydracids in the gaseous state the reaction is not so violent, but it is very characteristic. Since monopersulphuric acid oxidises the hydracids, and the water formed during the reaction can be absorbed by sulphuric acid, it was natural to try the action of this reagent on hydrofluoric acid. Our experiments showed that sulphate of potash is fairly stable in contact with fluorine in the cold, but decomposes when heat is applied. One series of experiments showed us that anhydrous hydrofluoric acid is perfectly stable in the presence of monopersulphuric acid; there is no hope, therefore, of preparing fluorine by this method. If we add anhydrous hydrofluoric acid to the solid reagent in a platinum crucible no reaction takes place; after about ten minutes, gas is given off by the evaporation of the hydracid. If we pass a current of hydrofluoric acid gas through a platinum tube containing the solid reagent, the gas escaping from the tube will not inflame crystallised silicon. The author also gives other experiments showing that there is no action with hydrofluoric acid similar to that with hydrochloric and hydrobromic acids.

Ammonium Amalgam.—Henri Moissan.—Already noticed.

Research on the Constitution of Compounds of Chromium.—G. Wyrouboff.—At the end of a very long paper the author summarises his results, and draws the double conclusion, that mineral compounds very simple in appearance may have a very complicated constitution, even as complicated as that of carbon compounds; and that our simple conceptions of inorganic chemistry ought to be considerably modified, and the idea of multiple functions should be introduced, as in organic chemistry.

The Separation of Glucinum.—G. Wyrouboff.—Already inserted.

Coloured Reaction of Uranium Salts with Peroxide of Hydrogen.—J. Aloy.—Will be inserted in full.

Some Salts of Benzylamine.—René Dhommée.—Already noticed.

Some Derivatives of Anthraquinone obtained from the Aloïnes.—E. Léger.—Already noticed.

The Production of Derivatives of Anthraquinone from the Aloïnes from Natal Aloes.—E. Léger.—*Action of Binoxide of Sodium on Nataloïne and on Homonataloïne.*—This reagent does not react in the cold on either of the two aloïnes in alkaline solution. The addition of hydrochloric acid to the yellow alkaline liquid precipitates the aloïnes unchanged. The same is the case on the water-bath. 250 c.c. of water at 80—85°, then 5 grms. of nataloïne, and a few drops of soda-lye are placed in a dish on the water-bath. Then 25 grms. of Na_2O_2 are gradually added during half-an-hour. The yellow solution takes a deeper colour, and when the reaction is finished even a thin layer appears orange-yellow. It is cooled, and hydrochloric acid added, and a yellowish brown flocculent precipitate is formed. The liquid is shaken up with its own volume of ether, which takes up the product and becomes yellow. The ethereal solution is distilled to dryness. Take up with boiling methylic alcohol, and allow to crystallise. The crystals are re-dissolved in boiling methylic alcohol; we then add washed animal-black, and boil for fifteen to twenty minutes, using a reflux condenser, then filter. The solution, concentrated by distillation, gives pale orange-yellow anhydrous needles, very long and fine. Homonataloïne gives the same body; its formula is found to be $C_{16}H_{12}O_5$.

MISCELLANEOUS.

University College Chemical and Physical Society.—On Wednesdays, February 25th and March 4th, at 8.30 p.m., Dr. M. W. Travers will lecture on "The Attainment and Measurement of Low Temperatures." There will be liquid hydrogen on both days. Visitors invited.

Royal Institution.—On Tuesday next (February 24th), at 5 o'clock, Sir William Abney will deliver the first of a course of three lectures at the Royal Institution on "Recent Advances in Photographic Science"; on Thursday, at the same hour, Prof. L. C. Miall begins a course of three lectures on "Insect Contrivances"; and on Saturday (February 28th), at 3 o'clock, Lord Rayleigh delivers the first of six lectures on "Light—its Origin and Nature." The Friday Evening Discourse on February 27 will be delivered by Adolph Liebmann on "Perfumes, Natural and Artificial"; on March 6th, by Prof. J. G. McKendrick on "Studies in Experimental Phonetics"; and on March 13th, by Prof. Karl Pearson on "Character Reading from External Signs."

Cyanide Poisoning.—At a recent meeting of the Council of the Chemical and Metallurgical Society of South Africa the matter of cyanide poisoning and its treatment was brought forward and discussed, and it was unanimously decided that in view of the widespread use of the cyanide process, and the accidents and ailments which arise therefrom, it was very desirable that the Society should investigate the nature of the poisoning and examine into the various remedies, antidotes, and treatments, with a view to discovering the most efficacious procedure in cases of poisoning, and recommending the same for general adoption by the industry. In pursuance of this discussion the Council has appointed a Sub-Committee, consisting of Messrs. A. F. Crosse, E. H. Johnson, and J. Yates, to carry out the necessary investigations and to report thereon. In starting upon their labours, the Sub-Committee is of opinion that it is necessary to have compiled particulars of the fatalities which have so far occurred and also the ailments both past and

existing, together with an account of the treatments adopted, and their effect. As this information is necessary, and will be, they are convinced, of the greatest service, they trust that as much detail as possible as regards treatment, &c., will be sent to the Secretary, Frederick Rowland, Assoc.C.I.S., Box 4375, Johannesburg, Transvaal.

Action of Hypophosphorous Acid on the Diazoic Compounds.—J. Mai.—The author has observed that when hypophosphorous acid reacts on the diazoïc compounds, the latter are reduced, giving the corresponding hydrocarbide as the principal product. When, for instance, the chloride of paradiazotoluene is added to hypophosphorous acid, and the mixture left for some days at 0°, 67 per cent of the theoretical amount of toluene is found in the product of the reaction. With chloride of diazobenzene the author obtained benzene and diphenyl; 3 grms. of aniline gave him 1 grm. of benzene and 0·5 grm. of diphenyl. The reaction with chloride of tetrazodiphenyl gave 60 per cent of the theoretical amount of diphenyl, and is a good method of preparing this hydrocarbide; chloride of diazonaphthalene gave naphthalene; in some cases it is advisable to help on the reaction by careful heating.—*Berichte*, vol. xxxv., p. 162.

New Method for the Direct Volumetric and Gravimetric Estimation of Mercury, Copper, and Zinc.—R. Cohn.—Mercuric thiocyanate, $(CyS)_2Hg$, is very slightly soluble in water, but is soluble in an excess of mercuric chloride or of an alkaline thiocyanate; in dilute solution, when acidulated with nitric acid, it does not colour ferric salts. We can estimate the mercury exactly in a solution of $HgCl_2$, for example, by adding first a little nitric acid and iron-alum, then a measured excess of a decinormal solution of $CySNH_4$; then we pour in a decinormal solution of nitrate of silver so as to pass the decolouration-point, and then add more thiocyanate until the brown colouration reappears and remains for some minutes. In an analogous manner we can estimate copper or zinc volumetrically, as these metals form double mercuric thiocyanates, $(CyS)_2Hg.(CyS)_2M$. To the solution under examination we add a known quantity of a solution of $HgCl_2$ and of $CySNH_4$. But in these latter cases we can also proceed gravimetrically by collecting and roasting the precipitate of the double thiocyanate.—*Berichte*, vol. xxxiv., p. 3502.

Direct Gravimetric Estimation of Boric Acid.—A. Partheil and J. A. Rose.—Boric acid is insoluble in anhydrous ether at the ordinary temperature, but it is slightly soluble in ether saturated with water (0·188 grm. in 100). On the other hand, it is not at all volatile in dry vacuo at the ordinary temperature, neither is it carried over by ether vapour. Hence, we get a method for its estimation by exhaustion with ether, something like the estimation of a fatty body. The apparatus used for the exhaustion by "perforation," consists of a tared matras into which 20—30 c.c. of ether is poured: this vessel communicates with a vertical condenser by means of a straight tube and a serpentine. In this latter we place the solution in which we wish to estimate the boric acid (for example, a borate with dilute hydrochloric acid), and the tubes are arranged in such a manner that the ether falling back from the condenser goes to the bottom of the serpentine tube, ascends this latter throughout its whole length while traversing the column of boriferous liquid, and finally discharges into the distilling flask without carrying with it any of the aqueous solution. The ether is kept boiling briskly for eighteen hours; the whole of the BoO_3H_3 having passed into the flask by this time, nothing remains but to detach the latter, allow the ether to evaporate off in a sulphuric acid desiccator, and weigh; the difference in weight gives the boric acid. It is important that the solution under examination should not contain sulphuric, nitric, phosphoric, or arsenious acids, nor notable quantities of Fe_2Cl_6 or $ZnCl_2$.—*Berichte*, vol. xxxiv., p. 3611.

Superphosphate as a Top-dressing for Grass Lands.—The total area under crops in the United Kingdom is over 47¾ million acres, and of this acreage nearly 28½ millions, or more than one-half, is returned as permanent pasture. It is admitted that much of this vast area of grass is stunted and starved, for the farm-yard manure produced is totally inadequate to fertilise even a portion of it. The great necessity for improving grass lands has occupied the attention of agricultural colleges and county councils during the past three years, and hundreds of experiments, conducted all over the United Kingdom, have demonstrated the fact that an application of 4 or 5 cwts. of superphosphate per acre not only increases the yield, but immensely improves the quality, with more after-grass and the suppression of moss. Many farmers have been working in the same direction, combining practice with science, and the Chemical Manure Manufacturers' Association have just issued a pamphlet comprising a selection from the numerous reports received. A perusal of them will be sufficient to convince anyone that the improvement of our pastures is a matter of prime importance, and that this can be effected at a low cost, either by superphosphate alone, when phosphates alone are deficient in the soil, or by a compound manure containing soluble phosphates, ammonia, and potash.

The Speed of Decomposition of Nitrite of Ammonium.—K. Arndt.—The author has examined the speed with which nitrogen is given off from solutions of nitrite of ammonium for temperatures comprised between 60° and 70°, and concentrations between 0·3 and 0·6 molecules per litre. This speed is tripled by an elevation of temperature of 10°. The non-dissociated portion of the nitrite of ammonium is split up into nitrogen and water under the influence of free nitrous acid. An addition of sulphate of ammonium accelerates the speed of the reaction, as it diminishes the electrolytic dissociation of the nitrite. Nitrite of sodium also prevents dissociation, and notably increases the concentration of the free nitrous acid. Salts which contain neither ammonium nor nitrous acid, on the contrary, diminish the speed of the reaction; the most active, from this point of view, are the salts of potassium; next, those of sodium, then those of magnesium; the sulphates are more active than the nitrates and the chlorides. This diminution of speed arises as much from the diminution of concentration of the ammonium nitrite as from the diminution of concentration of the free nitrous acid. The speed is diminished greatly by very small quantities of ammonia, and increased considerably by very small quantities of acid. Experiments show that in a solution of nitrite of ammonium at 0·6 molecule per litre, one-half per cent is split up into acid and base at 75°, and one-quarter per cent at 70°.—*Zeit. Physik. Ch.*, vol. xxxix., p. 64.

MEETINGS FOR THE WEEK.

MONDAY, 23rd.—Society of Arts, 8. (Cantor Lectures). "Paper Manufacture," by Julius Hübner.

TUESDAY, 24th.—Royal Institution, 5. "Recent Advances in Photographic Science," by Sir William Abney, K.C.B., D.C.L., F.R.S.

WEDNESDAY, 25th.—Society of Arts, 8. "Tonkin, Yunnan, and Burma," by Fred. W. Carey.

THURSDAY, 26th.—Royal Institution, 5. "Insect Contrivances," by Prof. L. C. Miall, F.R.S.

—— Society of Arts, 4.30. "Gleanings from the Indian Census," by Jervoise Athelstane Baines, C.S.I.

FRIDAY, 27th.—Royal Institution, 9. "Perfumes, Natural and Artificial," by Adolph Liebmann, M.A., Ph.D.

—— Physical, 5. "On the Measurement of Small Capacities and Inductances," by Prof. Fleming and Mr. Clinton. "On the Interpretation of Milne Seismograms," by Dr. Farr. "On the Thickness of the Liquid Film formed by Condensation at the Surface of a Solid," by Dr. Parks.

SATURDAY, 28th.—Royal Institution, 3. "Light—its Origin and Nature," by Lord Rayleigh, F.R.S., &c.

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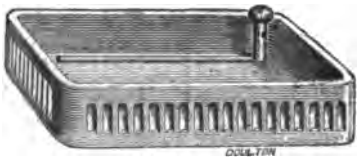

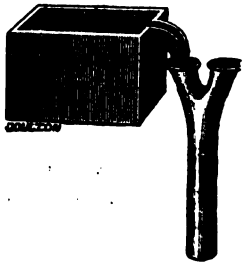

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Edited by Sir Wm. Crookes, F.R.S.] (WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE") [*Established by Mr. W. Keare.*

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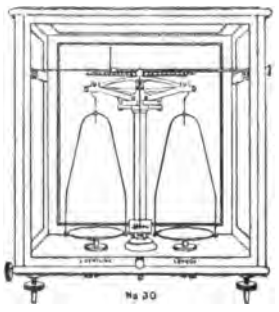

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THE CHEMICAL NEWS.

Vol. LXXXVII., No. 2257.

ON THE "EMANATION SUBSTANCE"* FROM PITCHBLENDE, AND ON RADIUM.

By F. GIESEL.

The radio-activity of the compounds of thorium and their characteristic emanation has been very thoroughly investigated by Rutherford (*c.f.* E. Rutherford and Soddy, *Zeit. für Physikal. Chem.*, 1902, xlii., 81). His endeavours to prove that the relatively very insignificant activity of thorium is due to the presence in very small quantity of a strongly active substance were unsuccessful. It is true that Rutherford, by extraction of thorium hydroxide with water or by precipitation of thorium salts with ammonia, obtained, after evaporation or expulsion of the ammonia respectively, small residues almost free from thorium, which were considerably more active than the thorium used, but the properties of these residues were altered. While the thorium by such treatment had lost a part of its activity, after some time it regained its original activity, but, on the contrary, the extracted substance, which Rutherford called "ThX," gradually decreased in activity up to the amount of the thorium present,†

Hence Rutherford concluded that the thorium itself must be the primarily active substance, and that "ThX" is formed from it continually by re-arrangement of the atoms.

Now, I have obtained a body from pitchblende (*Berichte*, 1902, xxxv., 3610), which, firstly, possesses to a considerably higher degree the same kind of activity as thorium, and secondly, unlike "ThX," has not diminished at all in linear radiation and emanation in about six months. But as the physical properties agree in other respects, and as it also appears to be related to thorium (and the rare earths), from these two new facts mentioned above we are led to adopt a different view from Rutherford's concerning the origin of the activity of thorium.

The emanation substance of pitchblende belongs to the group of cerium earths, or at any rate reacts in the same way. I have already shown (*Berichte*, 1902, xxxv., 3611) that the rare earths obtainable from pitchblende possess a constant activity. I was not then able to observe an emanation‡ because this, as has already been shown, does not belong equally to all compounds, but is dependent upon chemical conditions.

The method of preparation of the raw material for the emanation substance is the same as that employed for the separation of the rare earths, and is best effected by means of potassium sulphate, after removal of the heavy metals. Hydrogen peroxide gives with the solution of the potassium double salt a fairly active precipitate, displaying the emanation. The precipitate with oxalic acid, which also contains the emanation substance, and in consequence of the large amount of didymium contained in it is coloured faintly pink, yields no emanation. But a thoroughly rested eye may also perceive the activity of this last precipitate on the luminous screen.§

The preparation of this material, which is to be obtained in great quantity, must be deferred to a future period. For the present research the mother-liquor freed from radium bromide, and the greater quantity of barium bromide, sufficed; this has already been render richer in the emanation substance, *i.e.*, it contains it least adulterated with inactive earths. The treatment of this consisted in dissolving in hydrochloric acid the precipitate obtained with ammonia, after removal of any barium precipitated with it by means of sulphuric acid, and evaporating to dryness on the water-bath. On taking up the residue after evaporation with water, several centigrammes of an insoluble residue remained behind, which yielded the most strongly active (emanation) substance yet obtained. This residue was not investigated but reserved for the physical experiments.

The filtrate gave with sulphuretted hydrogen only a small active precipitate which contained lead. The precipitate obtained afterwards with oxalic acid amounted to about 2 grms. after further purification, and was almost as inactive as the insoluble residue. The precipitate formed by adding ammonia to the filtrate, and the final precipitate consisting of magnesia formed on addition of ammonium carbonate, were less active. Also the small remaining residue left on driving off the fumes from the last filtrate after evaporation was very active.

All precipitates, with the exception of those formed by oxalic acid and sulphuretted hydrogen, showed emanation which generally increased in the first few days. The ammonia precipitate, as well as the magnesia precipitate, contained small impurities of rare earths, after separation of which the activity correspondingly diminished, and grew stronger in the latter.

The oxalate of these earths becomes almost white on ignition, with a very faint salmon tint, and is then easily soluble in hydrochloric acid. The solution is at first orange, and becomes colourless with evolution of chlorine; similarly the solution in nitric acid on addition of hydrogen peroxide, but only very little cerium is obtained as hydroxide by the hydrogen peroxide reaction. The concentrated solutions of the salts show no trace of an absorption spectrum, and thus are practically free from didymium. Potassium sulphate, as well as hydrogen peroxide, completely precipitates the solution of the potassium double salt, which last gives also an emanation. Thiosulphate gives no precipitate on boiling, only a very slight turbidity. Ammonium oxalate does not extract from the oxalate sufficient thorium to be precipitated by ammonia. After driving off the ammonium salt a trace remains, which, however, is not more active than the undissolved oxalate. But it is noteworthy that the oxalate thus treated then gives the emanation very strongly.

Like the lanthanum salt the chloride crystallises easily, is itself phosphorescent after removal of water, and shows the emanation. In the Bunsen flame only the sodium line is visible spectroscopically. The sulphate forms definite crystals, and has no emanation or phosphorescence. According to these reactions thorium cannot be present to any material extent, and the traces present cannot be the cause of the activity. Lanthanum appears to be the essential impurity. It may be mentioned that the percentage amount of this earth present in a new radio-active element must be about 0·1 per cent, if it be assumed that the Becquerel radiation possesses the same intensity and the same power of penetration as in the case of radium. The Becquerel radiation of the preparation thus affects the barium platinum cyanide screen in the same degree as a barium carbonate with about 0·1 per cent radium. For a smaller intensity and power of penetration of the linear radiation than in the case of radium the percentage content would of course be higher. Thus in the case in question about 2 grms. must contain at least 2 m.grms. of the element. From what has already been stated, this can be neither radium nor polonium. For the present I will not follow the custom, usually adopted from practical considerations, of giving a name to the hypothetical element, until it has been established how Debierne's substance (actinium), hitherto

* *Berichte*, 1902, xxxv., 3608.

† The only temporarily active rare earths previously separated by me (*Berichte*, 1900, xxxiii., 3570,; 1901, xxxiv., 3776) from uranium mineral, as well as from commercial uranium salts (*Berichte*, 1900, xxxiii., 1665) behaved in the same way as "ThX."

‡ In all researches I have only paid attention to the emanation when it can be observed on the zinc sulphide screen.

§ Commercial thorium preparations do not affect the luminous screen.

known only as thorium, also behaves as regards the emanation.

In the examination of the physical properties of the emanation substance the following results have been obtained:—

The linear Becquerel radiation is capable of being deflected, at any rate partly, by a magnet. No decrease in it could be observed in about six months, but rather—as far as my observations go to show—an increase, similar to that in the case of radium. The degree of power of emanation of different preparations in the same chemical compound is proportional to the intensity of their Becquerel radiation. Igniting for a short time does not destroy the power of emanation.

Glass vessels in which the substance is kept phosphoresce, and on opening them the smell of ozone is perceptible.

The strong and rapid inducing effect of the substance is very striking. Most objects, *e.g.*, paper, which are shut up in the same receptacle (as small as possible) with the substance, very soon exhibit the same characteristics as the substance itself. If the preparation wrapped in paper is held at the back of the platinum cyanide screen for half to one minute the spot in question becomes luminous for a short time. No luminosity appears on laying on the varnished side of the screen.* This induction was clearly produced, not by the Becquerel radiation of the preparation, but by the emanation; it can be regarded as an absorption of the emanation, and is thus more easily perceived in porous substances, such as paper. The moisture present in the substance plays an important part in it. Wet filter-paper is made more strongly and lastingly active than dry. Impregnation with aqueous ammonia or hydrochloric acid gives the same result as with water.

By means of a current of air the emanation can be extended, so that the usual screens if they are unvarnished or prepared with gelatin (which absorbs the fumes) are rendered luminous by it. The phosphorescing zinc sulphide is best adapted for this purpose. The current of air momentarily discharges an electroscope. A thin film of celluloid intercepts the emanation.

If the preparation is laid in a cylindrical metallic capsule, closed at one end, and this is held vertically with the opening downwards towards a zinc sulphide screen negatively charged by an influence machine at a distance of from 5 to 10 c.m. from it, a diminished phosphorescence image of the opening of the capsule appears on the screen. This is brighter at the edge than in the middle. By inclining the screen, an elliptical instead of a circular surface is projected. A square opening gives an image in the form of a square with each of the sides slightly depressed in the centre.

If the opening of the capsule is diminished to any desired form, *e.g.*, by means of shaped shutters, very sharp, still more clearly and homogeneously luminous diminished images of the openings are obtained. The phosphorescent image so affects the screen that it becomes luminous for a long lime, and gives secondary emanation. If the capsule is insulated, the image becomes fainter. A current of air, which only extends the secondary emanation, no longer influences the position of the image. Direct convergence of the "beam of rays" could not be established; only a grouping together apparently takes place; generally the image is smaller for greater distances between screen and capsule. If the image is approached by a conductor connected to earth, in consequence of the positive charge induced by the negative screen, repellence takes place. The image is deformed to a straight or semicircular line, according to the shape of the conductor; the space between it and the conductor amounts to 1 to 2 c.m. A dielectric rod held between the screen and capsule does not repel so energetically, and only casts an enlarged shadow. If a wire net connected to earth (which interrupts the electric field) is held in the place of the rod, the screen remains dark; on insulating the wire net the emanation penetrates.

All the phenomena are the same if the screen is negatively charged and the capsule connected to earth, or if, conversely, the capsule is positively charged and the screen connected to earth.

From these experiments it follows that the emanation experiences in the electric field an acceleration in direction from the positive to the negative electrode. The emanation changes into a radiation; it must itself possess a positive charge.

Up to the present, with the means at my disposal, I have not been able to perceive any effect caused by a magnet in the emanation, which is influenced by the electric field.

The question whether the emanation is to be regarded as the positive ions, and the new radiation as a parallel to the channel radiation, or S_1 radiation of E. Goldstein (*Verh. d. Dtsch. Phys. Ges.*, 1902, iv., 228), or whether the emanation is simply the vapour of the substance itself, which, according to Curie's researches on radium, can itself assume a positive charge, may be left undecided. In any case, the emanation of my substance is very different from that of radium, which does not cause the phenomena described. I should suggest calling the new rays "E rays."

The measurement of the flame spectrum of radium Professor Runge has most kindly undertaken. He will report on it in *Drude's Annalen*, 1903, II., 1.

According to Professors Runge and Bodländer, the gas constantly evolved from solutions of radium bromide is essentially hydrogen.*

The following communication comes from Professor Bodländer:—

"The solution of 1 grm. of the 5 per cent radium preparation sent to me gave off 3·5 c.c. of gas in sixteen days. Seventy-eight per cent of this gas was hydrogen, and 17 per cent oxygen, while the solution became coloured brown by bromine. Thus a sort of electrolysis† occurs under the influence of the radium, in that the negative electrons change the hydrogen ions into neutral molecules, while by the positive electrons, bromine or hydroxyl ions are discharged. The experiments on the duration of the evolution of gas under different conditions will be continued, so that the source of the not inconsiderable energy (1·8 watt-seconds = 0·43 cal. = 18000 g.c.m. daily) obtained from about 5 c.g. of radium bromide may be explained."—*Berichte der Deutsch. Chem. Ges.*, 1903, xxxvi., 342.

Some Complex Compounds of Uranic Acid.—H. Itzig.—According to M. Kohlschutter, the tartrate of uranium prepared by Peligot should have the formula $C_4H_4O_6UO_3+3H_2O$ and not $C_4H_4O_6UO_2+4H_2O$. From the rotatory power of his solutions, which is seven times as much as that of tartaric acid, and also because of the fact that the reactions of tartaric acid and uranium are masked therein, the author is inclined to look upon this product as a urano-tartaric acid, $CO_2H(CHOH)_2CO_2UO_2OH$, a monobasic acid, of which the potassic salt is contained in uranic acid solution in the monopotassic tartrate. In the same manner we have a uranomalic acid, $CO_2H.CH_2.CHOH.CH_2UO_2OH$, of which the sodium salt has been obtained as a yellow, amorphous mass, very soluble in water, containing $2H_2O$. The rotatory power of malic acid is increased thirty times by the addition of uranium.—*Berichte*, vol. xxxiv., p. 3822.

* Only a pure radium salt with the highest activity produces a brief luminosity of the platinum cyanide, but it is immaterial which side of the screen was exposed to the radium.

* Two Geisler tubes which I had previously filled with radium gas (one with gas from solution and the other with gas from crystals) showed the hydrogen lines as plainly as possible. I did not then mention this, because it was not certain that the gas was absolutely free from water.

† (Author's note). The behaviour of radium solutions discovered by me (*Ann. d. Phys. u. Chem.*, 1899, lxix., 92) with regard to the radiation, as opposed to that of the solid salt, may be thus explained. The energy of the radiation is manifested in the solution more in the form of a decomposition of the water, and less as Becquerel radiation.

THE DETERMINATION OF STRYCHNINE AND BRUCINE IN *NUX VOMICA*.

By EDWIN DOWZARD, F.C.S.

Part I.—The Determination of Strychnine.

The method which has been most used for the determination of strychnine in the presence of brucine is the ferrocyanide process of Dunstan and Short. This process depends on the fact that when potassium ferrocyanide is added to the solution of a salt of strychnine, the ferrocyanide is precipitated as a white crystalline powder, only very sparingly soluble in cold water. The ferrocyanide of brucine is much more soluble than the strychnine salt.

The great objection to this process is that the brucine is more or less completely precipitated after standing for some time. This method, which has been adopted by the British Pharmacopœial authorities, has been criticised by Farr and Wright ("Year-book of Pharmacy," 1900), who state that unless the precipitation of the strychnine ferrocyanide takes place at a constant temperature, and the wash-water is always of the same amount and temperature, that constant results cannot be obtained, and that only when certain conditions are observed is it possible to obtain accurate results. Farr and Wright have suggested that the mixed ferrocyanides should be washed with 200 c.c. of acidulated water at 38° C., and that a correction be applied for the amount of strychnine dissolved. The weight of the mixed alkaloids, temperature at which precipitation takes place, volume and temperature of wash-water, size of filter-paper, speed of filtration, and volume of each washing, must all be taken into consideration. There are so many details which must be observed before accurate results can be obtained, that this method cannot be recommended for general use.

After trying various methods, I found that the nitric acid method gives the best results. This process depends on the following facts:—When strychnine is dissolved in dilute sulphuric acid and the solution treated with nitric acid, the alkaloid remains practically unaffected, and may be extracted with chloroform after the liquid has been made alkaline. When brucine is treated in the same manner, it is decomposed, and nothing—or practically nothing—can be extracted with chloroform.

The following is a description of the procedure I have found to give the most accurate results. The details of this method were fixed on after a large number of experiments:—

The mixed alkaloids must be first obtained in a practically pure state.

For extracting the alkaloids from *Nux vomica* seeds, a slight modification of Dunstan and Short's method may be used, which is as follows:—Mix 5 to 10 grms. of powdered *Nux vomica* seeds with a solution of 2 grms. of sodium carbonate (anhydrous) in 10 c.c. of water. Dry over a water-bath and reduce to powder. Exhaust this in a Soxhlet apparatus with a mixture of 3 parts chloroform and 1 part absolute alcohol until a small quantity of the percolate, on evaporation, yields a bitterless residue. Transfer the clear solution (filtered if necessary) to a separating funnel (stoppered), add 15 c.c. 4 per cent H_2SO_4, shake for five minutes, separate, and repeat twice, using 10 c.c. each time; filter the acid solution (mixed) through a cotton-wool plug, add excess of ammonia to the filtrate, and extract three times with chloroform (using 15 c.c., 10 c.c., and 5 c.c). The chloroformic solution is then passed through a small filter, the filter being washed several times with chloroform; the alkaloids are obtained on evaporation. The last traces of solvent should be removed by blowing air into the flask. The mixed alkaloids should be heated as little as possible.

The alkaloids are obtained from the liquid extract as follows:—Measure 5 c.c. of the sample into a small porcelain basin, add 10 c.c. of water, and evaporate to about 5 c.c. on a water-bath; add 5 c.c. of water and one drop of 20 per cent H_2SO_4, heat on bath for about two minutes, stirring continuously; then transfer to a separator, rinse out basin several times with small quantities of hot water, pour 5 c.c. of chloroform into the basin, and rub any adhering resinous or fatty matter with a glass rod until dissolved; transfer to separator, and repeat twice with 5 c.c. of chloroform; finally rinse the basin out with a few c.c. of hot water. The liquid should be kept as low in bulk as possible. Add to contents of separator 2 grms. of sodium carbonate (anhydrous) dissolved in 5 c.c. of water, shake for five minutes, heat separator by placing in a large beaker of water at 65° to 70° C.; the stopper should be occasionally removed to relieve the pressure (if these instructions are followed, a sharp clear separation will in most cases be obtained in a few minutes); separate the solvent, and extract the alkaline solution twice with chloroform, using 10 c.c. each time; heat to aid separation. Shake the mixed chloroform washings for one minute with 2 grms. of sodium carbonate dissolved in 15 c.c. of water; heat mixture to aid separation. This washing is to free the solvent from colouring matter. Extract the chloroform three times with 4 per cent H_2SO_4, using 10 c.c. each time; filter acid solution through a cotton-wool plug, washing the plug several times with water. The filtrate is made alkaline with ammonia and extracted three times with chloroform, using 10 c.c. each time. The solvent is filtered through a cotton-wool plug (fat free), and the plug washed several times with chloroform. The filtering apparatus I use for this purpose is made as follows:—A small hole is blown in the bottom of a test-tube, cotton-wool (fat free) is then packed into the tube until a column of about 2 to 2·5 c.m. is obtained. The liquid to be filtered is poured into the tube, the filtrate being conducted to the separator by a small funnel. The speed of filtration may be increased by placing the lips over the mouth of tube and blowing. The chloroformic solution is now shaken for twenty seconds with 15 c.c of water containing one drop of ammonia (sp. gr. 0·890); the alkaloids are obtained as described before.

The mixed alkaloids having been obtained in a pure state, the separation of the strychnine is effected as follows:—Dissolve the mixed alkaloids in 25 c.c. of 2 per cent H_2SO_4 (heat, if necessary, to aid solution), filter, and wash the filter-paper with 2 per cent H_2SO_4 until the filtrate measures 50 c.c.; cool to ordinary temperature (15—25° C.), and add 5 c.c. of nitric acid (sp. gr. 1·42); mix well, allow to stand for fifteen minutes, pour into a separator containing 15 c.c. ammonia (sp. gr. 0·890) and 10 c.c. of chloroform, shake mixture for five minutes; after separation has taken place, the solvent is transferred to another separator and the alkaline liquid again extracted with 10 c.c. of chloroform.

To 44 c.c. of water add 1 c.c. of ammonia (sp. gr. 0·890). The chloroformic solution is shaken for twenty seconds with 15 c.c. of the above dilute ammonia solution. After separation has taken place, the solvent is transferred to another separator; this treatment is repeated twice. (The chloroformic solution is washed with dilute ammonia to free it from a small quantity of colouring matter). The solution of strychnine is transferred to a tared wide-mouthed short-necked flask (capacity about 150 c.c.), the solvent is distilled off until about 1 c.c. is left, 1 c.c. of

Weight of alkaloids taken.		Strychnine found.
Brucine.	Strychnine.	
0·0500	0·0500	0·0500
0·0500	0·0500	0·0501
0·0500	0·0750	0·0749
0·0500	0·0750	0·0750
0·0750	0·0750	0·0751
0·0750	0·0750	0·0750
0 0750	0·1500	0·1499
0·1500	0 0750	0·0753
0·1500	0·1500	0·1501
0·1500	0·1500	0·1502

absolute alcohol is added, and the flask placed in an air-bath kept at a temperature of about 80° C.; when the last trace of alcohol has been driven off, the temperature is raised to 100° C. The flask is weighed till constant.

The accuracy of this method was proved by the experiments shown in Table.

Part II.—The Determination of Brucine.

The most distinctive reaction of brucine is the production of a red colour with nitric acid. This, I thought, might be useful as a means of determining brucine in the presence of strychnine, as the latter alkaloid is not affected by nitric acid, only a slight yellow colour being produced on standing. The following method was decided on after a large number of experiments.

A solution is made containing 0·16 grm. brucine (anhydrous) and 0·16 grm. strychnine in 100 c.c. of 2 per cent H_2SO_4. The mixed alkaloids are obtained as described in Part I. of this paper. The filtered chloroformic solution of the pure alkaloids is not distilled, but made up to 50 c.c. Ten c.c. of this solution is evaporated to dryness in a tared beaker, and the residue dried at 105—110° C, till constant in weight. The remaining 40 c.c. is distilled until about 1 c.c. is left in the flask; this is removed by blowing air into the flask and heating gently. If the alkaloids are heated too strongly they turn a light brownish colour, which interferes with the results. The weight of mixed alkaloids is calculated from the weight obtained from 10 c.c. The colourless alkaloidal residue is dissolved in 25 c.c. of 2 per cent H_2SO_4, heating gently to aid solution. The liquid is filtered into a graduated cylinder, and the filter-paper washed with 2 per cent H_2SO_4 until the filtrate contains 0·1 grm. mixed alkaloids in 50 c.c.

Fifty c.c. of the standard brucine solution and 50 c.c. of the liquid containing 0·1 grm. mixed alkaloids are placed in two small beakers, 5 c.c. of nitric acid (sp. gr. 1·42) is added simultaneously to the contents of each beaker, the mixtures are agitated, and transferred to the comparison troughs of a Gallenkamp colorimeter. Five minutes after the addition of nitric acid the liquids are compared, the mean of six readings is taken, and the amount of brucine calculated. Fifty c.c. of the standard brucine solution contains 0·08 grm. brucine; this equals 100 on the colorimeter scale. If the solution of mixed alkaloids gave a reading of 60 on the scale, the amount of brucine present in 0·10 grm. mixed alkaloids would be 0·048 grm. (100 : 60 :: 0·08 : 0·048). Before this instrument (Gallenkamp's colorimeter) is used, it should be standardised by a brucine solution of known strength. If possible the observations should be made by daylight; good results, however, can be obtained by gas-light. The light should be reflected from a piece of white cardboard. Care must be taken that the light is perfectly diffused; otherwise, accurate results cannot be obtained. The accuracy of this method was proved by the following experiments:—

Alkaloids taken.		Colorimeter readings.	Brucine found.
Strychnine.	Brucine.		
0·0500	0 0500	(63·5, 63·0, 63·5, 62·5, 63·0, 63·0) .. .. 63·08	0·0504
0·0600	0 0400	(50·5, 49·5, 50·0, 50·5, 50·5, 50·5) .. .. 50·25	0·0402
0·0700	0·03C0	(37·5, 37·5, 37·5, 37·0, 38 0, 37·5) .. .. 37·50	0·0300
0·0300	0·0700	(88·5, 88·0, 87·5, 88 0, 87·5, 88·0) .. .. 87·91	0·0703
0·0400	0·0600	(76·0, 76·0, 76·5, 75 0, 75·5, 76·0) 75 83	0 0606

The determination of the strychnine and brucine by the methods given above may be made on the same portion, thus placing a check on the results. In this case, 10 grms. of the powder, or 10 c.c. of the liquid extract, should be operated on, as described in Part I.

The filtered chloroformic solution of mixed alkaloids is made up to 50 c.c.. Ten c.c. is evaporated, and the residue dried at 105—110° C. for total alkaloids. The remaining 40 c.c. is evaporated to dryness as described before, dissolved in 40 c.c. of 2 per cent H_2SO_4, filtered, and the filter-paper washed with 2 per cent H_2SO_4 until the filtrate measures 100 c.c. Fifty c.c. of this solution is used for the determination of strychnine, the amount of mixed alkaloids in the remaining 50 c.c. is calculated, and the solution diluted until 50 c.c. contains 0·1 grm.; the brucine is then determined as above.

In the following example I have given the figures obtained in the examination of a sample of *Nux vomica* powder. The strychnine, brucine, and total alkaloids were determined separately.

Nux vomica Powder.

50 c.c. chloroform = alkaloids from 10 grms. of sample.
10 c.c. of above = 0·064 grm. mixed alkaloids = 3·2 per cent.

The remaining 40 c.c. was evaporated, and the residue dissolved in 100 c.c. 2 per cent H_2SO_4.

50 c.c. of above = 0·0585 grm. strychnine = 1·462 per cent.
50 c.c. of above = 0·1480 grm. mixed alkaloids; after diluting to 64 c.c., 50 c.c. = 0·100 mixed alkaloids.
Average of six readings, 67·5 (100:67·5 :: 0·08:0·054);

$$\frac{0{\cdot}054 \times 3{\cdot}2}{0{\cdot}1} = 1{\cdot}728 \text{ per cent brucine.}$$

	Per cent.
Found—Total alkaloids	3·200
Strychnine	1·462
Brucine	1·728
Brucine calculated	1·738

The greater part of the expense of this investigation was defrayed by means of a Government grant.

THE SPECIFIC HEATS OF METALS AND THE RELATION OF SPECIFIC HEAT TO ATOMIC WEIGHT.*

Part II.

By W. A. TILDEN, D.Sc., F.R.S.,
Professor of Chemistry in the Royal College of Science, London.

The following values have been obtained for the mean specific heats of pure aluminium, nickel, cobalt, silver, and platinum, within the several limits of temperature indicated:—

Centigrade.	Aluminium.	Nickel.	Cobalt.	Silver.	Platinum
−182° to +15°	0·1677	0·0838	0·0822	0·0519	0·0292
−78 ,, +15	0·1984	0·0975	0·0939	0·0550	—
+15 ,, 100	—	0·1084	0·1030	0·0558	0·0315
15 ,, 185	0·2189	0·1101	0·1047	0·0561	—
15 ,, 335	0·2247	—	—	—	—
15 ,, 350	—	0·1186	0·1087	0·0576	—
15 ,, 415	—	0·1227	—	—	—
15 ,, 435	0·2356	0·1240	0·1147	0·0581	0·0338
15 ,, 550	—	0·1240	0·1209	—	—
15 ,, 630	—	0·1246	0·1234	—	—
0 ,, 1000	—	—	—	—	0·0377*
0 ,, 1177	—	—	—	—	0·0388*

* Violle (*Comptes Rendus*, 1877, vol. lxxxv., p. 543; also *Phil. Mag.* [5], vol. iv., p. 318).

From these results the specific heats at successive temperatures on the absolute scale have been calculated, and

* Abstract of a Paper read before the Royal Society, Dec. 11, 1902.

it appears that the assumption of a constant atomic heat at absolute zero is untenable.

The mean specific heat of a sample of nickel steel, containing 36 per cent of nickel and having remarkably small dilatation, was found to be as follows:—

Range of temperature.	Mean specific heat.
−182° to +15°	0·0947
15 „ 100	0·1204
15 „ 360	0·1245
15 „ 600	0·1258

The mean specific heats of the sulphides of nickel and silver were also determined with the object of getting some evidence as to the cause of the difference observed between the two metals in regard to the influence of temperature on their respective specific heats. The following are the values obtained:—

Range of temperature.	NiS.	Ag_2S.
−182° to +15°	0·0972	0·0568
15 „ 100	0·1248	0·0737
15 „ 324	0·1333	0·0903

The mean value for the specific heat of silver sulphide is less than that for nickel sulphide throughout, but little can be deduced from the results till the influence of temperature on the specific heat of sulphur is known.

THE EVAPORATION OF WATER IN A CURRENT OF AIR.*

By EDGAR PHILIP PERMAN, D.Sc., F.C.S., Assistant Lecturer in the University College of South Wales and Monmouthshire.

The object of this investigation was to discover with what accuracy the vapour-pressure of water could be calculated from the amount of water vapour carried off by an air current passed through the water, the temperature being maintained constant. The method adopted was to aspirate air, at a rate of not more than 0·1*l.* per minute, through a succession of wash-bottles containing water and placed in a thermostat. The water carried off by the air was absorbed by means of concentrated sulphuric acid, and weighed. The vapour-pressure was calculated from the expression:—

$$V.\phi = \frac{W \times 1{\cdot}242 \times 760 \times P \times T}{T(W \times 1\,242 \times 760) + 273 \times V \times p};$$

where W = Weight of water drawn off.
P = Pressure in the last wash-bottle.
T = Absolute temperature of air in aspirator.
V = Volume of air drawn through the water, measured at temperature and pressure of aspirator.
ϕ = Pressure of air in aspirator.

The results obtained show in every case a close agreement between the calculated vapour-pressure and that commonly accepted. Experiments were made at temperatures varying from 20° to 90° C. It may be concluded from this that in air saturated with moisture (under the conditions used in the experiments) the pressure of the aqueous vapour is the same as the vapour-pressure of water when no other gas is present, also that the density of the aqueous vapour in the mixture is normal. It follows also that the density of saturated aqueous vapour, *without* admixture of any other gas, is approximately normal. This conclusion is confirmed by calculations of the density from the thermo-dynamical equation—

$$L = \frac{T}{J}(s' - s)\frac{dp}{dT}$$

using Griffiths's values of L and J, and the latest determinations of vapour-pressure at the Reichsanstalt for the values of dp/dT.

A *resumé* is given of the various determinations of the density of saturated aqueous vapour.

* Abstract of a Paper read before the Royal Society, February 19th, 1903.

ANALYTICAL NOTES.

By EDMUND J. MILLS, D.Sc., F.R.S.

1. In the usual routine of qualitative separation, the filtrate, after passing hydric sulphide, is boiled and treated with nitric acid. If any iron be present, oxidation is imperfect, and some of the ferrous iron passes through the next group, to be precipitated by ammonic sulphide as "traces of nickel." For many years I have been in the habit of using bromine-water, which is a perfect oxidiser, instead of nitric acid. It also has this advantage—that the desired excess of it can be readily detected by sight and smell.

2. The precipitate with ammonic sulphide is generally very difficult to filter, owing to the presence of some sulphur compound, presumably the pasty hydric persulphide. The remedy usually prescribed is prolonged boiling. I have always found the addition of a few grms. of sodic sulphite to the hot liquid (with precipitate) produce immediate clarification. As the metallic sulphides do not dissolve, this plan may be adopted for quantitative work.

A REACTION OF CACODYLIC ACID AND THE CACODYLATES.

By J. BOUGAULT.

Very few positive reactions are known with cacodylic acid and the cacodylates; the ordinary reagents do not precipitate them, with the exception of mercurous nitrate, which gives a precipitate with the cacodylates, at first white and almost immediately becoming yellow. I should mention also Barthe and Péry's reaction described in the "Manipulations de Pharmacie," by E. Gerard, p. 222.

The new reaction I am about to describe is very characteristic, very sensitive, and very easy to carry out. It enables us to detect traces of cacodylates, even when mixed with the methylarsenates, which resemble them very closely in their composition.

The reagent employed is the hydrochloric solution of hypophosphorous acid, that I have described already (*Journ. de Pharm. et de Chim.*, 1901, Series 6, vol. xv., p. 528) as being very sensitive in the detection of arsenic in the form of arsenites and arsenates, in the most varied products.

If we place a small quantity of cacodylate of sodium dissolved in about 1 c.c. of water in a test-tube, and then add about 10 c.c. of the reagent and cork up the tube, after a time, which varies with the proportion of cacodylate present, a very distinct cacodylic odour is developed. Even with half a milligrm. of cacodylate, this odour becomes perfectly distinct after a contact of twelve hours, and no deposit of arsenic is formed in the liquid. But with larger quantities of cacodylate, we observe, on the upper part of the test-tube above the surface of the solution, a deposit of arsenic which is produced slowly, and continues to increase for several days. I only mention this latter fact without laying any stress on it, as the odour is both more sensitive and more to be depended upon.

The methylarsenates behave in quite a different manner. They do not cause any cacodylic odour, and all the arsenic present is liberated and precipitated.

The presence of the methylarsenate does not interfere with the reactions of the cacodylate. But the inverse is

not quite the case, the reduction of the methylarsenate is less sensitive in the presence of a cacodylate than when the salt is pure.

In any case, these facts show that the hypophosphorous acid reagent can be utilised as follows:—

1. To detect cacodylic acid and the cacodylates, and especially for their detection in the presence of disodic methylarsenate:—We place 0·20 grm. of methylarsenate in a test-tube, and dissolve it in 2 c.c. of water, add 10 c.c. of the reagent, and leave in contact in the cold for twelve hours in the corked tube. At the end of this time a strong cacodylic odour is perceived, if the substance contains a cacodylate, even if the amount is only half a milligrm.

2. To detect the presence of other arsenical compounds in cacodylates:—We place 0·20 grm. of cacodylate of sodium in a test-tube, and dissolve it in 1 to 2 c.c. of water and 10 c.c. of the reagent. The pure cacodylate does not cause any colouration, or any deposit of arsenic in the liquid; the least trace of arsenic (less than a tenth of a milligrm. of arsenious acid or of arsenic) produces a brown colouration or a precipitate; it is advisable to keep to the dilution mentioned, viz., 1 to 2 c.c. of the aqueous solution to 10 c.c. of the reagent.—*Journ. de Pharm. et de Chim.*, Series 7, vol. xvii., No. 3.

ON THE CAUSE OF THE DETERIORATION OF PLATINUM CRUCIBLES FROM THE CALCINATION OF AMMONIO-MAGNESIC PHOSPHATE.

By W. C. HERÆUS.

CHEMISTS who have frequently to calcine precipitates of ammonio-magnesic phosphate, often observe the deterioration of the platinum crucibles used for this operation.

The crucible cracks or flakes, the metal shows a crystalline structure in the fracture, and sometimes there are evidences of fusion; very often these faults are attributed to the quality of the metal, and apparently *à priori* with reason, inasmuch as the same deterioration is not observed in other laboratories.

M. Heræus, a manufacturer of platinum apparatus, who frequently has such complaints from his clients, has examined this question carefully, and, as a result of this examination, has arrived at the following conclusions:—

1. The quality of the platinum has no influence on its resistance; pure platinum and that alloyed with 10 per cent of iridium or rhodium does not last any better than the ordinary metal.

2. The phenomena observed are due to the formation of phosphorus.

3. Magnesic pyrophosphate is reduced by carbon at and above 950°, with the production of phosphorus.

4. The reducing gases, especially hydrogen, produce the same phenomena at 900°.

5. Ammonia which is dissociated at a high temperature is, on account of the hydrogen it contains, an eminently reducing gas.

6. The action of ammonia is the more intense if the precipitate contains an excess of ammonic phosphate; that is to say, if, owing to the conditions of precipitation, it contains the phosphate, $(NH_4)Mg(PO_4)_2$, described by Neubauer (*Zeit. f. Anorg. Ch.*, 1892, [2], p. 45, and 1893, [4], p. 251; *Zeit. f. Angew. Ch.*, 1896, ix., No. 14.

Thus the deterioration of platinum crucibles depends on the method of working followed in the estimation. The author leaves it to the chemists interested to decide which method to follow. It is evident, first of all, that it is necessary to proceed in such a manner as to prevent the formation of the precipitate of the mono-magnesic phosphate mentioned above; next in importance, it is necessary to prevent the ammonia given off during calcination coming in contact with the magnesic pyrophosphate at a high temperature. Thus, care must be taken to heat the precipitate of ammonio-magnesic phosphate very gently at first, and with the crucible uncovered, so as to get rid of the ammonia before the residue reaches the temperature at which reduction might take place.

It is not advisable to collect and calcine successively several precipitates of phosphate in the same crucible, as is the custom, especially when using a Gooch crucible; as a matter of fact, in such a case it may happen that the ammonia of the last precipitate may act on the pyrophosphate of the preceding estimation.

The method of procedure, which consists in treating the precipitate with nitric acid at once, so as to obtain the white pyrophosphate at the first onset, is evidently the best way to prevent any reduction, and consequently any attack of the platinum.—*Zeit. f. Angewandte Ch.*, 1902, xv., p. 917.

A COLOURED REACTION OF THE SALTS OF URANIUM AND PEROXIDE OF HYDROGEN.

By J. ALOY.

THE coloured reactions of the salts of uranium are not very numerous. The precipitation of the uranic salts by potash, and the subsequent solution of the precipitate by the alkaline carbonates, give only a slightly characteristic yellow liquid.

As for the action of ferrocyanide of potassium, it gives a precipitate of variable colour, according to the conditions of the experiment. Like the preceding one, this reaction is only applicable to solutions of the salts at maximum strength, and it is entirely hidden by the presence of numerous metals, and especially by traces of iron.

The method I am about to describe enables us, on the contrary, to recognise the presence of uranium very rapidly.

On adding peroxide of hydrogen and then carbonate of potassium, either in the solid state or in very concentrated solution to a compound of this metal, we obtain a solution which has a very beautiful red colouration.

This method is very general, and can be applied to not only the yellow salts, but also to the uranous compounds and even to the anhydrous oxides. Still, in this latter case, it is preferable first to transform the oxide into nitrate by means of nitric acid. Further, this reaction succeeds in the presence of metals whose salts give with carbonate of potassium a precipitate insoluble in an excess of the carbonate, which is the general rule.

Bicarbonate of potassium is not capable of replacing the neutral carbonate, and, under the same conditions, gives a yellow liquid which becomes red on heating.

The sensitiveness of the method can be increased by making use of the property of the red compound, of being insoluble in alcohol. If to the red solution obtained as I have shown, we add two or three times its volume of strong alcohol, we obtain a red precipitate, which collects rapidly at the bottom of the vessel used.

The same reaction may be used for the detection of peroxide of hydrogen. A soluble uranic salt, such as the nitrate, is treated with carbonate of potassium in sufficient quantity to dissolve the precipitate which is first formed. The addition of peroxide of hydrogen to this solution produces a beautiful red colouration. If we wish to detect traces of peroxide of hydrogen, it is better to operate in a different manner, and to make a solution of uranic nitrate in alcohol at 95°, and then add a few drops of the solution to be tested and a few crystals of carbonate. In the presence of peroxide of hydrogen either a red precipitate or a red liquid is formed, which collects at the bottom of the vessel.

The reaction I have described takes place in two phases. In the first phase, the peroxide of hydrogen transforms the uranium compound into the white peruranic hydrate; in the second, this hydrate is decomposed by the alkaline carbonate. We know, from the work of Fairley, and the more recent researches of Mélikoff and Pissarjewsky, that the simultaneous action of peroxide of hydrogen and the alkalis on the uranic salts, gives rise to the formation of yellow per-uranates insoluble in alcohol. By using very dilute solutions of soda in the presence of alcohol, Fairley obtained a red oily liquid which he looked upon as a mixed per-uranate of uranium and sodium. I have repeated Fairley's experiment, operating as much as possible out of contact with water; for this purpose I treated a solution of the nitrate in ether with strong peroxide of hydrogen, and then with an alcoholic solution of soda. Under these conditions I obtained a red precipitate similar to that produced by the action of carbonate of potassium.

These red bodies consist of heavy precipitates which adhere very strongly to the sides of the vessel in which they are formed. They are very unstable, and lose a portion of their oxygen very rapidly at the ordinary temperature. They are soluble in water and insoluble in alcohol and ether. I have attempted to make use of their insolubility in alcohol to separate them in a definite form, but without success, for the solution in water and the precipitation by alcohol are accompanied with a partial decomposition of the compounds, which lose oxygen as well as their original red colour. Nevertheless, by substituting treatment with methylic alcohol for the treatment with water and ordinary alcohol, I succeeded in preparing red peroxidised compounds of uranium having a crystalline appearance, which I am examining at the present time.—*Bull. Soc. Chim.*, Series 3, vol. xxvii., No. 14.

THE FIFTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY, BERLIN, 1903.

It will be remembered that the first of these International Congresses was held at Brussels in 1894, this was followed by three others at Paris in 1896, Vienna in 1898, and Paris again in 1900. Berlin has been selected as the meeting-place for the fifth Congress, and this will be held from June 2nd to 8th, 1903, under the Presidency of Dr. Otto N. Witt.

The meetings of the Congress will take place in the Imperial Parliament House, the general meetings being held in the large hall. Like its predecessors, the Congress will be divided into sections, the meetings of which will be held in the Committee rooms of the House.

The Congress begins with an inaugurative evening reception on Tuesday, June 2nd; on Wednesday, June 3rd, the first General Meeting will be held at 10 a.m.; in the afternoon the Sections begin their work, and this will be continued on June 4th. On Friday, June 5th, a second General Meeting will be held at 10 a.m., when an Address will be delivered by Professor Henri Moissan, President of the Fourth Congress. On Friday afternoon and Saturday the meetings of the sections will be continued; on Sunday, the 7th, there will be a general excursion. The meetings of the sections will be continued and finished on Monday morning. In the afternoon the third General Meeting will be held, in which the business of the Congress will be discussed and brought to a conclusion. Besides the above meetings there will be a number of social arrangements, of which full particulars will be given.

The object of these International Congresses is to promote both the scientific and economic interests of chemical work by introducing uniform standard methods and regulations throughout the world. They propose to elucidate the points of view which are of importance for Government regulations concerning transport and duties. They are also intended to provide an opportunity for the mutual understanding of different branches of chemical work, as well as to improve the personal acquaintance between the representatives of the various branches of chemical work in different countries.

The English Section will be represented on the Organising Committee by the following gentlemen:—The Royal Society by Professor J. Emerson-Reynolds, Professor H. E. Armstrong, W. H. Perkin, and T. E. Thorpe. The British Association for the Advancement of Science by Professor James Dewar, Sir Henry Roscoe, and Professor R. Meldola. The Royal Society of Edinburgh by Professor John Gibson, J. B. Readman, and James F. Pullar. The Royal Institution by Sir William Crookes, George Matthey, and Dr. Ludwig Mond. The Chemical Society by Professor William Tilden, Professor W. R. Dunstan, Alexander Scott, and W. H. Perkin, jun. The Society of Chemical Industry by Ivan Levinstein, Thos. Tyrer, and Walter F. Reid. The Institute of Chemistry of Great Britain and Ireland by Professor J. Millar Thomson, G. T. Beilby, and Julius Lewkowitsch. The Iron and Steel Institute by R. A. Hadfield, J. E. Stead, and Bennett H. Brough. The Royal Agricultural Society by Aug. J. Voelcker. The Society of Public Analysts by Otto Hehner and Bertram Blount. The Federated Institute of Brewing by A. Gordon Salamon and Cornelius O'Sullivan; and the Honorary Secretary of this Joint Committee will be Mr. F. E. Armstrong.

The Congress will be divided into eleven Sections as follows:—Section I., Analytical Chemistry, Apparatus and Instruments. Section II., The Chemical Industry of Inorganic Products. Section III., Metallurgy, Mining, and Explosives. Section IV., The Chemical Industry of Organic Products, divided into Sub-sections, A, On Organic Products, including Coal-tar Products, and, B, Dye-stuffs and their Applications. Section V., The Sugar Industry. Section VI., Fermentation and Starch Manufacture. Section VII., Agricultural Chemistry. Section VIII., Hygiene, Medicinal and Pharmaceutical Chemistry, the Chemistry of Alimentary Products. Section IX., Photographic Chemistry. Section X., Electro- and Physical Chemistry. Section XI. Legal and Economic Problems referring to Chemical Industry. The subscription is 20 marks (£1) for the whole Congress, and for ladies, who may take part in the social arrangements, 15 marks (15s). Full particulars may be obtained on application to the Office, 21, Marchstrasse, Charlottenburg, bei Berlin.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month Ending January 31st, 1903.

By SIR WILLIAM CROOKES, F.R.S.,
and
PROFESSOR DEWAR, F.R.S.

To Charles Perrin, Esq., M.Inst.C.E.,
Water Examiner, Metropolis Water Act, 1871.

London, February 10th, 1903.

Sir,—We submit herewith, at the request of the Directors, the results of our analyses of the 220 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from January 1st to January 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Com-

bustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in previous reports.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 220 samples examined by us during the month, all were found to be clear, bright, and well filtered.

For the first time since June, 1900, we have to record an excess of rain at Oxford, the actual rainfall during January has been 2·58 inches; the average fall is 2·08 inches; this gives an excess of 0·5 inch, or 19·3 per cent for the month, on the thirty-five years' average.

Our bacteriological examinations of 377 samples have given the results recorded in the following table; besides these we have examined 197 other samples, from special wells, standpipes, &c., making a total of 574 samples in all:—

	Microbes per c.c.
New River, unfiltered (mean of 26 samples) ..	319
New River, filtered (mean of 78 samples) ..	13
Thames, unfiltered (mean of 26 samples) ..	13161
Thames-derived water, from the clear-water wells of eight Thames-derived supplies (mean of 193 samples)..	69
Ditto ditto .. .. highest	562
Ditto ditto .. .. lowest	0
River Lea, unfiltered (mean of 27 samples) ..	313
River Lea, from the East London Company's clear-water wells (mean of 27 samples) ..	38

Of the 298 daily samples taken from the filter-wells of the Metropolitan Water Companies, and examined bacteriologically by us, thirteen samples, or 4·3 per cent, were sterile; forty-five samples, or 15·1 per cent, contained more than 100 microbes per c.c.; and twenty-one of these samples contained more than 150 microbes per c.c. The mean number of microbes in the forty-five samples containing more than 100 microbes was 198, against a corresponding mean of 177 in twenty-three samples in December.

Owing to the great increase in the rainfall during the last month, the microbes in the unfiltered Thames water have risen from about 6000 to 13,000, that is, the bacteriological impurity has about doubled, whereas the unfiltered New River water has undergone little or no alteration. The result of this increase has been that the filters of the Thames-derived Companies, which were not working at their best, furnished a larger number of samples from the filter wells, showing an increase in the number of microbes. In our last Report we pointed out that this would be the inevitable result in the event of an increased rainfall.

In comparison with last month there has been a small increase in the soluble organic matter, and the average colour due to this cause has been correspondingly increased.

It is of interest to compare the quality of the supply during last month, which was abnormally wet, with that of January, 1902—one of the driest months of that exceptional year. In January, 1902, the organic matter was about two-thirds of the present amount, while the bacteria amounted to about one-half. In neither case, in the majority of the samples, did the microbic impurity exceed what is allowable in a good and wholesome water.

We are, Sir,
Your obedient Servants,

WILLIAM CROOKES.
JAMES DEWAR.

PROCEEDINGS OF SOCIETIES.

PHYSICAL SOCIETY.

Annual General Meeting, February 13th, 1903.

Prof. S. P. THOMPSON, President, in the Chair.

THE following Report of the Council for the year 1902 was read:—

Since the last Annual General Meeting of the Society the usual number of meetings has been held. One of these, on June 13th, 1902, was held at the National Physical Laboratory at Bushy House, on the kind invitation of the Director, and was well attended in spite of a downpour of rain; another, on November 28th, was held at the Royal College of Science, by the invitation of Professor Callendar; and that which should have been held on June 27th took place on June 20th, owing to the fact that the former day had been declared a National Holiday.

The Society has to mourn the loss of several Fellows by death. Among these occur the names of Sir F. Abel, Dr. J. H. Gladstone, the first President of the Society, Mr. G. Griffith, long an active member of the Council, Sir W. Chandler Roberts-Austen, first Secretary of the Society, and Mr. James Wimshurst. Memoirs of some of these will be found in the Proceedings. Professor Cornu and Professor R. Felici, Hon. Fellows of the Society, also died during the year.

The Council also regrets that, owing to the calls of business, Mr. Elder has found it necessary to resign the post of Secretary. They feel that the Society owes a debt of gratitude to Mr. Elder for the energy and devotion with which he has ministered to the interest of the Society during the last decade.

There have been four resignations, and eleven new Fellows have been elected. The numbers are therefore well maintained.

The Bulletins of the Proceedings of the Meetings have been sent out regularly in accordance with the terms of Mr. Stanley's generous gift to the Society.

A new agreement for a term of three years has been arranged between the Society and the Institution of Electrical Engineers to provide for the continuation of *Science Abstracts*, and it is hoped that the usefulness of this publication will be thereby increased.

The Treasurer presented the balance-sheet together with the following report:—

The receipts for the present year do not include any exceptional sources of revenue such as life-compositions or donations. On the other hand, there are additional sources of expenditure, (1) on the International Catalogue £16 4s. 9d., (2) on the printing and distribution of abstracts of proceedings, about £35. In spite of this the bill for printing has been somewhat below the average, so that the revenue has just balanced the expenditure. The difference between the bank balance of £167 13s. 3d. at the beginning of the year and the balance of £68 6s. 6d. at the end of the year, is satisfactorily accounted for by the investment of about £98 from the current account, in addition to £571 10s. 5d. from the deposit account, in the purchase of Great Eastern Railway Debentures. By this purchase and the gift of L. B. & S. C. Ry. stock from Mr. W. F. Stanley, the revenue of the Society from investments has been materially increased, and will next year amount to about £115. The payments made to *Science Abstracts* next year will be reduced to about £256 under the new agreement with the Institution of Electrical Engineers. Thus, although some increase in the printing bill may be expected, it is probable that the revenue will continue to balance the expenditure.

The following Officers and Council were elected for the ensuing year:—

President—R. T. Glazebrook, D.Sc., F.R.S.
Vice-Presidents—Those who have filled the Office of President together with T. H. Blakesley, M.A.; Prof. J. D. Everett, D.C.L., F.R.S.; S. Lupton, M.A.; J. Swinburne.
Secretaries—W. R. Cooper, M.A.; W. Watson, D.Sc., F.R.S.
Foreign Secretary—Prof. S. P. Thompson, D.Sc., F.R.S.
Treasurer—Prof. H. L. Callendar, M.A., F.R.S.
Librarian—W. Watson, D.Sc., F.R.S.
Other Members of the Council—C. Chree, D.Sc., F.R.S.; W. B. Croft, M.A.; F. G. Donnan, M.A., Ph.D.; H. M. Elder, M.A.; R. A. Lehfeldt, D.Sc.; Prof. J. Perry, D.Sc. F.R.S.; A. W. Porter, B.Sc; W. A. Price, M.A.; W. F. Stanley, F.G.S.; W. C. D. Whetham, M.A., F.R.S.

Dr. R. T. Glazebrook then took the Chair and delivered an Address. After thanking the Members for electing him to the office of President he referred to the work of Gladstone, Roberts-Austen, Griffith, and Wimshurst, four Fellows whom the Society had lost by death since the last General Meeting. The Society had also lost two Honorary Fellows in Ricardo Felici and Alfred Cornu. Stokes was not a Fellow of the Physical Society. The Society regretted it, and were poorer for it. Turning to domestic affairs, Dr. Glazebrook mentioned the retirement of Mr. Elder, after ten years' work as Secretary. The membership of the Society was almost stationary instead of increasing, and it was necessary to consider how best to further the interests of the Society. It should have a wider range of activity, and technical papers should not necessarily be excluded. If possible all papers should be sent out, in full or in abstract, before any meeting, so as to encourage discussion. Interest might also be aroused by arranging at times for set discussions. The Society was at a disadvantage in having no home of its own, and the time of meeting might be reconsidered. Attempts should be made to give advice and guidance to physicists in isolated positions about the country having time to carry out research. The rest of the Address dealt with the history of theoretical optics during the last sixty years, and the part taken by Stokes in its development.

The Society then adjourned until February 27th.

NOTICES OF BOOKS.

An Introduction to the Study of Metallurgy. By Sir W. C. Roberts-Austen, K.C.B., F.R.S., &c. Fifth Edition, Revised and Enlarged. London: Charles Griffin and Co., Ltd. 1902. Pp. 516.

This volume is one of a series of treatises written by Associates of the Royal School of Mines, and the fact that it is now in its fifth edition affords ample evidence of the appreciation it has met with at the hands of students, practical metallurgists, and chemists.

Sir William Roberts-Austen, whose lamented death at the latter end of November last is still fresh in our memories, was perhaps the foremost metallurgist of his day, and had made his mark not only as a scientific worker but as a teacher of metallurgy.

There is no need to recapitulate here the contents and arrangement of this volume; it is already known and appreciated by all metallurgists, and we can do no more than heartily recommend its careful perusal to students, coupled with the regret that they will be unable to share with their predecessors the advantages of the personal assistance and teachings of the late professor of metallurgy at the Royal School of Mines.

We must point out an evident oversight in the date of the preface to this edition; it is given as "December, 1902," and as Sir W. Roberts-Austen's death occurred on November 22nd last, it would give the impression that he was not the writer of the preface, though from its wording t was evidently his work.

A Text-book of Quantitative Chemical Analysis. By Frank Julian. First Edition. Illustrated. St. Paul, Minn.: The Ramsey Publishing Company. 1902. Pp. 604.

This volume is divided into four principal parts and an appendix, and is intended for the use of students who, having a fair acquaintance with the elements of general chemistry, can devote a limited time to quantitative analysis concurrent with or following the usual qualitative course; it will be found also to be very useful as a book of reference to the general analytical chemist, who cannot be expected to have every method at his fingers' ends; though, owing to limitations of space, full details of every method cannot be given.

Part I. deals with the elementary principles of chemical analysis, such as sampling, weighing, and the various manipulative operations necessary to carry out a quantitative chemical analysis by the gravimetric method. This is followed by special sections giving the broad outlines and general methods in vogue for volumetric analysis, gasometry, and attributive methods, by which are meant certain methods based on other properties, common or special, besides weight and volume, or the measure of a chemical reaction, that stand in a definite relation to mass. Among these may be mentioned specific gravity, melting- and congealing-points, spectrum analysis, flash-points, &c.

Part II., which covers 51 pages, consists of a number of exercises in quantitative analysis of very varied kinds, such as cast-iron, ginger, potassium chlorate, chloral hydrate, nickel-copper alloy, air, &c.

Part III., which is the largest and most valuable portion of the book, is devoted to special methods and technical analysis, and includes the fire assay, colorimetry, electrolysis, ultimate and proximate organic analysis, the alkaloids, tannins, carbohydrates, oils, soaps, dye-stuffs, &c.

Part IV. contains notes and observations on the principles and practice of analysis, which may be useful to students, while the appendix contains certain observations on technical and industrial analysis, in which the great and growing value of the chemist cannot be over-estimated. There is a good index of ten columns.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 5, February 2, 1903.

Etherification of Mannite by Phosphoric Acid.—P. Carré.—Whilst repeating MM. Portes and Prunier's experiments on the etherification of mannite by phosphoric acid, the author observes the two following facts:—(1) Water is given off before the etherification starts, which seems to show that there is a dehydration of the mannite itself under the influence of phosphoric acid. (2) The velocity of etherification of the equimolecular mixture is much slower than is usually the case with the primary alcohols. In spite of numerous efforts, the author is not able to isolate in at all a pure state the salt of the di-ether formed with a prolonged heating action. In no case does he prove the formation of a non-salifiable ether, because in the various etherifications effected the whole of the acid used in the reaction can be recovered.

Bulletin de la Société Chimique de Paris. Series 3, Vol. xxvii., No. 15.

Micrometric Assay of Gold Ores.—M. Gerreau.—Already inserted in full.

Pasty Condition assumed by Aluminium in the Neighbourhood of its Melting-point, and the Application of this Property to the Division of the Metal.—Albert Granger.—Already inserted in full.

Apparatus for the Examination of Contact Action. The Use of a Platinum Spiral.—A. Trillat.—To obtain good results in an apparatus with an incandescent platinum spiral, the contact action should be limited, and after the contact of the vapours examined, these should be cooled and isolated immediately. The platinum spiral must be arranged so that it can be raised to incandescence without heating the sides of the vessel containing it, and resistances must be arranged so that the temperature can be varied. The apparatus, of which a figure is given in the original, consists of a tube of thin glass of 10 to 15 c.m. long by about 8 m.m. diameter; this tube contains the platinum spiral. The lower part of this tube, which must be vertical, is fixed to a brass or silver tube of 6 m.m. outside diameter by means of an indiarubber tube; the upper end of the tube is fixed to a copper tube in the same manner. These two metallic tubes are connected by a spiral of platinum wire. The whole of this portion of the apparatus is placed in a glass cylinder 25 to 30 c.m. long by 8 wide, containing water, which serves to cool the vapours which have been in contact with the incandescent spiral. The substance to be examined is placed in a flask heated either directly or in a water-bath. The flask should have rather a long neck, and the cork must have two holes, through one of which passes a tube 7 or 8 m.m. diameter, bent at a right angle, and connected to the upper end of the copper tube. Through the other hole passes a tube reaching to the bottom of the flask. The lower end of the brass tube is connected with a flask of 100 or 200 c.c., closed with a cork having three holes through which tubes pass connected with various wash-bottles and reagent flasks. The flask itself is packed in ice. The vapour is drawn through the whole system by attaching the end to an exhaust pump or aspirator. The incandescence of the spiral is effected by means of an electric current and a rheostat for its regulation. The rest of the paper gives the precautions to be observed in carrying out the experiments.

Lactates of Mercury.—Marcel Guerbet.—Already inserted in full.

Sulphurised and Nitrated Derivatives of Sulphide of Carbon. V. Thiosulphocarbamic Derivatives of the Secondary Aromatic Amines. VI. Imidodithiocarbamic Aromatic Ethers.—Marcel Delépine.—Already noticed.

The Detection and Presence of Rennet in Plants.—Maurice Javillier.—Though much work has been done on the coagulation of milk with rennet, no one appears to have made experiments under sufficiently rigorous conditions. There are many microbes capable of coagulating milk, but no one appears to have sterilised the milk used in these experiments. The author has been working on strictly aseptic lines, and took rye-grass (*Lolium perenne, L.*) as the subject of his experiments. Rye-juice was prepared and saturated with chloroform and left for twenty-four hours in a stoppered flask in the dark; it was then filtered. Fifty drops of this juice were added to 10 c.c. of sterile milk, and a second tube of milk was treated with 50 drops of the juice, which had been boiled for fifteen minutes. The first tube was coagulated after three and a-half hours in the incubator at 38°. The second one was not coagulated at all. Thus rye-grass juice contains rennet, but rennet is destroyed on heating to 70—75°. Experiment showed that 45° is the optimal temperature for the action of this rennet. At low temperatures—such as 0°, 11°, and 16°—no coagulation takes place. Further experiments show that this rennet is influenced by dilution. Equal volumes of the filtered juice and sterile water coagulated milk in two hours, while a dilution of 4 parts of sterile water to one of juice took more than ten hours to coagulate milk. This rennet will act in neutral media, but its action is helped by acids and hindered by alkalis. The author gives, finally, a list of the plants in which he has found vegetable rennet; they number seventeen.

MISCELLANEOUS.

The Oxalo-uranous Salts.—V. Kohlschutter.—*Uranous oxalate*, $(C_2O_4)_2U+6H_2O$ (the author has doubled this formula in order to explain the composition of the following salts):—When $C_2O_4H_2$ is added to a solution of uranous chloride, a greyish precipitate is formed; its solution in oxalate of ammonium being poured into hydrochloric acid in a thin stream, the salt is re-precipitated in the form of green quadratic prisms. *Acid Uranous Oxalate*, $2(C_2O_4)_2U.C_2O_4H_2+8H_2O$.—A nearly white precipitate is formed when we add a large excess of $C_2O_4H_2$ to UCl_4; water or dilute acids decompose it, giving the neutral salt, and this latter cannot be brought back to the state of acid salt by the addition of $C_2O_4H_2$. *Diuranous Chloro-trioxalate*, $(C_2O_4)_3Cl_2U_2+12H_2O$.—Five grms. of $(C_2O_4)_2U$ are heated with 60 grms. of concentrated HCl, the salt dissolves, and the solution is left to cool; it is not oxidisable in the air; when water is added it gives a white precipitate which contains all the uranium. When left in the desiccator with sulphuric acid for one or two days it forms small colourless flakes grouped together in tufts or spherical masses; at 100° this body loses first water, then HCl, and becomes rose-coloured. *Diuranous Sulphate-trioxalate*, $(C_2O_4)_3SO_4U_2+12H_2O$.—Five grms. of $(C_2O_4)_2U$ are dissolved in 75 c.c. of concentrated HCl, and after cooling, it is poured drop by drop into dilute sulphuric acid until a persistent cloudiness is formed. Soon a greenish-grey precipitate is formed consisting of very small needles; this salt is decomposed by water; with an excess of dilute sulphuric acid we obtain the following salt:—*Uranous Sulphate-oxalate*, $C_2O_4.SO_4U+3H_2O$.—Three grms. of $(C_2O_4)_2U$ are boiled with 20—30 c.c. of dilute sulphuric acid; the salt becomes gradually deep olive-green coloured, and changes into small tabular prisms. This salt is insoluble in water and in dilute acids, neither is it decomposed by them; it is the most stable of the series. *Uranous Sulphate*, $(SO_4)_2U+4H_2O$.—Triturate $U(C_2O_4)_2$ with concentrated H_2SO_4, and pour the whole into alcohol; a slightly bluish white powder is deposited, free from oxalic acid. This salt dissolves in water at first, but is soon decomposed; it dissolves in dilute sulphuric acid, giving an oxidisable liquid, without doubt the acid sulphate; the addition of an excess of concentrated sulphuric acid precipitates small needles of neutral sulphate crystallised with $2H_2O$. On the other hand, if we let the solution of uranous sulphate in dilute sulphuric acid evaporate, we get dark green orthorhombic plates, isomorphous with sulphate of thorium, and of the same composition as the original bluish-white salt, but this new salt is insoluble in dilute sulphuric acid; the author regards it as a polymer with the double formula, $(SO_4)_4U_2+8H_2O$. The sulphuric solution of the original salt, treated with alkaline sulphates, gives the green, crystallised, double salts, $SO_4K_2.(SO_4)_2U+2H_2O$ and $4SO_4(NH_4)_2.(SO_4)_2U+3H_2O$. —*Double Uranous Oxalates.*—The solution of $(C_2O_4)_2U$ in $C_2O_4K_2$ on concentration and cooling, gives very soluble grey crystals, $2C_2O_4K_2(C_2O_4)_2U+5H_2O$, and these, on the addition of $BaCl_2$, give a violet-red, microcrystalline precipitate, $2C_2O_4Ba.(C_2O_4)_2U+6H_2O$. By evaporation in the cold we can obtain another uranosopotassic oxalate, $3C_2O_4K_2.(C_2O_4)_2U+4H_2O$, in green prisms; on boiling with water the latter gives $C_2O_4K_2(C_2O_4)_2U+8H_2O$, a greyish-white crystalline powder. *Chloro-oxalate of Thorium*, $(C_2O_4)_3Cl_2Th_2+9H_2O$. —Five grms. of $(C_2O_4)_2Th$ are dissolved at a gentle heat in 50 c.c. of concentrated hydrochloric acid; the solution, cooled and evaporated to dryness, deposits spherical tufts formed of plates of the chloro-oxalate; this salt is decomposed by water, and resembles the uranous salt.—*Berichte*, vol. xxxiv., p. 3619.

Exhibit of Irish Minerals and Building Stones at the Imperial Institute, London.—The Department of Agricultural and Technical Instruction for Ireland have taken steps to place on view for a period of three months at the Imperial Institute, London, the extensive collection of Irish minerals and building stones which formed one of the most interesting and valuable of their exhibits at the recent Exhibition in Cork. The exhibit will embrace samples of the varied and excellent building materials and marbles in which Ireland is particularly rich, and it is expected that the opportunity of examining these samples will be of advantage to those who are concerned in the many large building schemes now in progress in London and elsewhere in Great Britain. The beauty and excellence of the Irish granites, sand-stones, and limestones, as well as of the red, green, and black marble, and the other ornamental stones of the country, are well known, and when shown at the Department's Exhibit at Cork excited the admiration of all who saw them. The exhibit also includes specimens of clays, cement-making materials, and fine sands. In the mineral section of the exhibit are a series of prospectors' samples of the metalliferous deposits of the country, and samples of Irish coal and other minerals now being worked. The Mineral Expert to the department will remain with the exhibit during the period mentioned, and all inquiries should be addressed to E. St. John Lyburn, F.G.S., Irish Mineral Section, Imperial Institute, London, S.W. The Exhibition will be open free to the public from February 26th, 1903, between the hours of 11 and 5. Admission will be by the East Public Entrance of the Imperial Institute.

MEETINGS FOR THE WEEK.

MONDAY, March 2nd.—Society of Arts, 8. (Cantor Lectures). "Hertzian Wave Telegraphy in Theory and Practice," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S.

—— Society of Chemical Industry, 8. "The need of Duty-free Alcohol for Industrial Purposes," by Thomas Tyrer, F.I.C., &c.

TUESDAY, 3rd.—Royal Institution, 5. "Recent Advances in Photographic Science," by Sir William Abney, K.C.B., D.C.L., F.R.S.

—— Society of Arts, 4.30. "The Uganda of To-day," by Herbert Samuel, M.P.

WEDNESDAY, 4th.—Society of Arts, 8. "Education in Holland," by J. C. Medd.

—— Society of Public Analysts, 8. "A Plea for the More Extended Consideration of Physics in Analytical Methods," by H. Droop Richmond, F.I.C. "Note on some Vanadium Reactions," by C. A. Mitchell, B.A., F.I.C. "Note on Adulterated Bees' Wax" and "The Solubility of certain Mineral Salts in Ether," by Otto Hehner, F.I.C.

THURSDAY, 5th.—Royal Institution, 5. "Insect Contrivances," by Prof. L. C. Miall, F.R.S.

—— Chemical, 8. "The mechanism of the Reduction of Potassium Bichromate by Sulphurous Acid," by H. Bassett. "The Constitution of Pilocarpine" (Part IV.), by H. A. D. Jowett. "Preparation and Properties of 1.4 (or 1.5) Dimethyl Glyoxaline and 1.3 Dimethyl Pyrazole," by H. A. D. Jowett and C. E. Potter. "Some Analyses of 'Reh,' or the Alkaline Salts in Indian Usar Land," by E. G. Hill. "Experiments on the Synthesis of Camphoric Acid—Part III., Synthesis of Isolauronolic Acid," by W. H. Perkin, jun., and J. F. Thorpe. "Camphor-β-thiol," by T. M. Lowry and G. C. Donington. "Isomeric Change of Dibenzanilide into Benzoylorthoamino- and Benzoylpara-aminobenzophenone," by F. D. Chattaway. "The Rate of Decomposition of Diazo-compounds—Part III., The Temperature Coefficient," by J. C. Cain and F. Nicoll.

FRIDAY, 6th.—Royal Institution, 9. "Studies in Experimental Phonetics," by Prof. J. G. McKendrick, F.R.S., &c.

SATURDAY, 7th.—Royal Institution, 3. "Light—its Origin and Nature," by Lord Rayleigh, F.R.S., &c.

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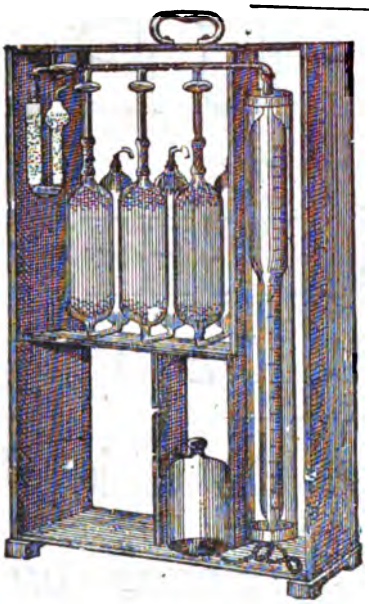

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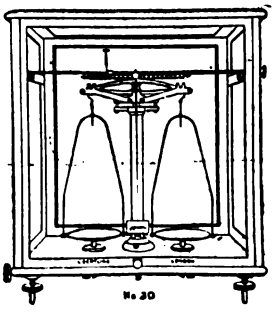

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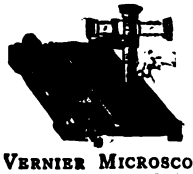

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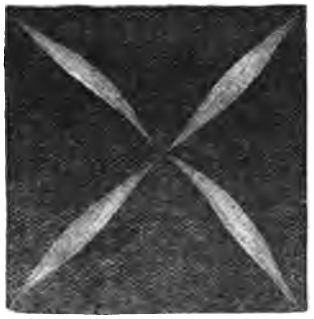
THE CHEMICAL NEWS.

Vol. LXXXVII., No. 2258.

ON THE FORMATION OF DEFINITE FIGURES BY THE DEPOSITION OF DUST.*

By W. J. RUSSELL, Ph.D., F.R.S.

The author shows that when a plate of glass or other material is slightly warmed and allowed to cool for six or seven minutes in a dust-laden atmosphere, a clear and definite figure is formed on the plate. The figure is determined by the form of the plate on which it is deposited. If a square plate is used then a simple cross is formed, a ray of deposit proceeds from each corner of the plate to the centre. If the plate be triangular, a ray again proceeds from each corner; and with an octangular plate an eight-rayed star is formed. In every case the number and position of the angles of the plate determine the form of the figure. The dust generally used was that produced by burning magnesium ribbon, but any fine dust acts in the same way and produces the same figures.



With regard to the plate on which the figure is deposited, its composition is not of importance except as a back-ground for the dust. A glass plate for many reasons is best, but the figures form with equal certainty and sharpness on one of copper, or mercury, or ebonite, or indiarubber, or card-board, &c. In order to heat the plate it may be passed several times over the flame of a lamp, warming it as uniformly as possible, and, if it be a glass plate, until the moisture condensed on the under side has disappeared; or the plate may be heated by laying it on a copper plate heated to about 120° C. for thirty minutes, or it may simply be warmed in an air- or water-bath. The plate is best supported on three pieces of wire about 1½ inches long, and a receiver filled with the dust, inverted over it and allowed to remain there for six or seven minutes.

In order to obtain symmetrical figures the plate on which they are deposited must be perfectly horizontal, and as they are very sensitive to heat, there must be no unequal heating either of the plate or the surrounding atmosphere while the deposition is taking place.

As long as the plate and the surrounding atmosphere are nearly of the same temperature only very imperfect figures form, but as the temperature rises a more and more nearly perfect figure appears. If the plate be above 17°, indications of pictures are produced when the plate is at a slightly lower temperature than the surrounding atmosphere, but when the difference is 6° or more, these indications cease altogether. Very good pictures are produced by having the plate at 12° or more degrees above the dust-laden air, and even when the plate is 100° or 120° above the air, distinct but thin pictures are produced. The effect of a slight heat below the plate, while the deposit is taking place, is shown to thicken the figure and distort it in a curious manner, and is illustrated by photographs. Also the effect of radiant heat on these figures is shown by the action of a Bunsen burner at distances of 12 and 26 inches, and of other sources of heat at considerable distances from the plate. Some singular and complicated effects are produced by placing a source of heat above the plate instead of below it. A large number of experiments are also recorded and illustrated showing the effect which different bodies in the immediate neighbourhood of the plate have on the figures which are formed. Taking only one case, that of a pin. When it is placed in contact and at right angles to the plate a definite deposit is produced, and this varies as the pin is moved further and further away, and as it is placed either on a level with plate, or above or below it. Even when the pin is 6 m.m. below the level of the plate, and 2 m.m. away from it, a distinct effect is produced. Again, these dust currents may be influenced in a remarkable way by suspending glasses of different sizes, and at different heights above the plate on which the figures are depositing, and photographs of the figures produced are given. The effects produced by obstructions of different sizes laid on different parts of the plate are also shown.

It was also found that a current of dust drawn through a tube will form a characteristic figure on a plate, which need not be warmed, as it passes over it.

If the magnesia dust be allowed to settle on a surface of water, about the temperature of 17° C. or, on water containing a very small amount of alcohol or glycerin, the deposit which forms on the surface breaks up, by the powder sinking, into a figure of cellular form.

Magnesia dust, which was generally used, undergoes some strange changes. When first deposited it is removed by the slightest touch, but if the plate be kept for a week or fortnight it may then be softly brushed over without damage to the figure. Another change which this powder undergoes is shown by collecting it immediately it forms, and examining it under a microscope, when it will be found to consist of irregular shaped and separate particles, but if the collection of the dust be made a few minutes after its formation, it is then seen that the particles are strung together, forming small and irregular fibres. In the various figures that have been produced the magnesia seems to have assumed this form.

* Abstract of a Paper read before the Royal Society, February 19th, 1903.

ESTIMATION OF THE FREE ANHYDROUS AND HYDRATED LIME IN CONCRETES.

By M. MAYNARD.

In January, 1897, during the course of some experiments in the laboratory at La Rochelle, we were led to try whether it would not be possible to estimate the free anhydrous or hydrated lime contained by all hydraulic products, no matter how carefully they have been manufactured.

Water acting on all concretes either to dissociate or to dissolve them, and acids of all kinds acting chemically on these products, it appeared impossible to estimate the free lime in them.

However, we can estimate this substance with sufficient approximation by having due regard to the following considerations:—

For this estimation it is necessary to find a body which does not contain any water which is able to dissolve lime without dissolving or dissociating the component parts of the cement, especially the aluminates and the tricalcic silicate. Now, chemically pure glycerin gives with lime a glycerinate of which the heat of formation is only 0·50 cal.: CaO + glycerin = glycerin . CaO + 0·50 cal.

Therefore by saponifying the cement with glycerin we ought to be able to dissolve the free lime only.

The first experiments were undertaken in December, 1898, on various products.

1. *Hydraulic Lime marked "Nivet," from Marans (Lower Charente).*—Three samples of 0·1 grm. of this lime were taken on December 8th, and each placed separately in contact with 50 c.c. of glycerin. On December 11th, one of these three samples were treated with 50 c.c. of absolute alcohol, and filtered on December 12th. A quantity of free lime was obtained equal to 35 per cent. On December 19th a second sample was treated with 40 c.c. of absolute alcohol, and filtered on December 20th; free lime equal to 34 per cent was obtained. On December 25th the third sample was treated with only 20 c c. of absolute alcohol, and filtered on December 26th. The free lime obtained was equal to 28 52 per cent.

2. *Rapid Setting Cement, from Fumel (Dordogne).*—Unsifted cement, taken just as it came:—

On November 13th four assays were commenced on 1 grm. of cement, treated with 50 c.c. of glycerin.

On November 17th one sample was treated with 50 c.c. of absolute alcohol, and filtered on November 18th. The free lime = 5·33 per cent.

On November 23rd the second was treated with 50 c.c. of absolute alcohol, and filtered on the 24th. The free lime was 4·43 per cent.

On December 4th the next was treated with 50 c c. of absolute alcohol, and filtered on December 5th. The free lime was 4·93 per cent.

On December 9th the last was treated with 50 c c. of absolute alcohol, and filtered on December 10th. The free lime was 4·83 per cent.

Fine dust of cement passed through a silk sieve:—

On November 19th 1 grm. was placed in contact with 50 c.c. of glycerin, and on December 9th it was treated with 50 c.c. of absolute alcohol. The free lime found was 4·50 per cent.

On November 30th a sample of 0·5 grm. of cement was placed in contact with 50 c.c. glycerin; on December 7th 50 c.c. of absolute alcohol were added, and it was filtered on December 8th. The free lime found was 5·75 per cent.

3. *Cement marked Z, from Boulogne.*—The experiment was made in duplicate on November 20th and 30th, 1898. On November 20th 1 grm. of cement was put in contact with 50 c.c. of glycerin in four different flasks.

After 19 days	we obtained	3·75	per cent	of free lime.
„ 23	„	3·29	„	„
„ 29	„	3·12	„	„
„ 35	„	3·20	„	„

On November 30th 0·5 grm. of cement was put in contact with 50 c.c. of glycerin in three different flasks:—

After four days the amount of free lime obtained was 4·18 per cent; after nine days, 4·00 per cent; after twelve days, 4·21 per cent.

The variations between these two sets of results may be caused by the 50 c.c. of glycerin exhausting the free lime from the 0·5 grm. of cement more easily than from the 1 grm.

The first experiments were concluded by the estimation of the hydrated free lime contained in a block of Vicat maritime cement, of which we have spoken when referring to the action of sea-water on concretes, and which had been submerged since May 31st, 1859, at the foot of the Saint-Nicolas tower:—

The three assays made, gave:—

After 3 days	contact,	2·62	per cent	of free lime.
„ 10	„	2·70	„	„
„ 14	„	2·34	„	„
which gives a mean of		2·55	„	„

The chemical composition of this product is rather variable, as can be seen from the analyses we give below:—

Moisture at 120°	22·30	23·40
Moisture between 120° and 180°	4·40	
Silica, soluble in alkalis	16·50	20·50
Silica, insoluble in alkalis	5·10	
Alumina	3·44	8·05
Peroxide of iron	2 55	2·75
Lime	32 64	31·00
Magnesia	3·69	3 04
Carbonic acid	7·44	9·50
Sulphuric acid	1 19	1·08
Chloride of sodium	0·65	0 60
	100·00	100·00

These first essays enable us to observe that glycerin was without action on the component parts of the cement, and that it was preferable, so as to prevent the agglutination of the cement, to add silica, and to give more fluidity to the glycerin to keep it at about 40°. Next we carried out a second series of experiments on a Portland cement mixed with and immersed in fresh water and salt water; this was analysed after varying periods of immersion. A cement marked "Couronne," from Boulogne was used.

For the estimations of the mixed and submerged cement, we made cubes of 0 06 metre of pure cement, of which one series was mixed with, and immersed in, fresh water, while the second was mixed with, and immersed in, sea-water.

These cubes were left untouched under water during the whole course of the trials, and the water was renewed every week. At fixed dates the cubes were withdrawn, dried at 120°, and broken up, and the samples for the estimation of the free lime taken from the interior in the centre of the blocks.

	Cement in powder.	Cement made with 23 per cent of fresh water and immersed in fresh water for—				
		24 hours.	30 days.	3 months.	6 months.	1 year.
	P.c.	P.c.	P.c.	P.c	P.c.	P.c.
Silica	14·20	20·10	20·60	20 20	19 70	19·50
Alumina	15 90	9·19	8·00	6·08	7 59	11·25
Oxide of iron	2·50	2·01	2·50	2·72	2 01	2·55
Lime	65·15	61·90	62·89	62 48	55·74	51·70
Magnesia	0·14	0·10	0·12	traces	0 08	0 09
Sulphuric acid	0·75	0·80	0 45	0 68	0·82	1·24
Chloride of sodium	—	0·20	0·13	0·89	0·17	0·23
Loss from 120° to red heat	0·30	5·50	4·90	6·60	12·50	13·30
CO_2, and difference	1·06	0·20	0 41	0·35	0·55	0·15
Free lime on the cement dried at 120°	6·02	7·415	10·60	14·03	14·355	11·70

	Cement in powder.	Cement mixed with 23 per cent of sea-water and immersed in the same for—				
		24 hours.	30 days.	3 months.	6 months.	1 year.
Silica	14·20	20·50	20 60	20 00	19·60	19·00
Alumina	15·90	8 95	8·25	7·23	7·13	10·01
Oxide of iron	2·50	2·15	1·93	2 07	2·07	2 70
Lime	65·15	61 60	61·97	60·00	52·92	46 10
Magnesia	0·14	0·15	0·13	0·43	0 07	0·56
Sulphuric acid	0·75	0·89	0·85	0 82	1 05	4 28
Chloride of sodium	—	0·26	0·32	1 40	2 82	2·93
Loss from 120° to red heat	0·30	5·10	5·80	7·60	13·50	13·80
CO_2, and difference	1·06	0·40	0·15	0·45	0·74	0 78
Free lime on the cement dried at 120°	6·02	8·51	12·525	12·87	12·275	10·20

At the commencement of the estimations, after the period of contact with the cement was over, we diluted the glycerin with absolute alcohol which does not dissolve lime but facilitates the filtration of the solution. We em-

ployed another method also, which consists of heating the pure glycerin to 60° at the commencement of the filtration; this was effected by means of an apparatus with a continuous stream of warm water; at this temperature the surface tension of the glycerin is *nil*, and it is quite fluid.

The method of working is as follows:—

1. Weigh out accurately about 0·5 grm. of the cement under examination, and place it in a conical Erlenmeyer flask of about 150 c.c. capacity.

2. Raise 50 c.c. of pure glycerin to a temperature of 60°, and note exactly its volume in the graduated vessel holding it.

3. Pour the glycerin over the weighed cement, and close the neck of the flask with a plug of cotton-wool; shake for a few minutes, and place in an oven at 40°.

Care must be taken to note the volume of glycerin which remains in the graduated vessel, so as to know the exact volume of glycerin at 60° that was poured on to the cement.

Suppose, for example, that the volume of the glycerin used was 51 c.c. at the temperature of 60°, and the weight of the cement in contact with it 0·480 grm.

4. Leave the Erlenmeyer flask for five days in the oven, taking care to shake up the contents every day.

5. On the sixth day, filter the greater portion of the glycerin, taking care to keep the temperature up to about 60°.

We are of the opinion that this process will be very useful for observing the action of fresh water or of sea-water on submerged concretes. Thus we can follow the decomposition of mortars and verify their state of preservation.

We may remark that according to the results obtained we have never found proportions of 25, 30, and 44 per cent of free lime in Portland cements, as found by MM. Hart, Stener, Wermser, and Spaujer.—*Bull. Soc. Chim.*, Series 3, vol. xxvii., No. 16.

THE ACTION OF CHROMIC ACID ON CARO'S REAGENT.

By A. BACH.

Following on my experiments on the action of chromic acid on peroxide of hydrogen, I have examined the action of this oxidising agent on Caro's reagent.

We know that the product of the action of concentrated sulphuric acid on persulphate of potash does not act on chromic acid after its dilution with ice. On the other hand, I found that the undiluted product attacked chromic acid very vigorously either in the solid state or in sulphuric solution. There is a simultaneous reduction of the two bodies, with a liberation of oxygen and the formation of sulphate of chromium.

As I have shown in a previous paper (*Moniteur Scientifique*, 1901, p. 25), Caro's reagent behaves in quite an analogous manner with permanganate of potassium. In a dilute condition it has no action on the permanganate, but, on the other hand, when concentrated it reduces the solid permanganate or permanganic anhydride in sulphuric solution very energetically, with the liberation of oxygen and the formation of sulphate of manganese. In a large number of experiments I have noticed that the amount of oxygen given off in this case was almost exactly one-third more than the amount of reduced permanganic anhydride would have given off with peroxide of hydrogen. I have endeavoured to explain this fact by admitting that, under the influence of great concentration, 3 molecules of persulphuric acid combine to form a superoxygenated acid, analogous to tetroxide of potassium, and, like this latter, contain an ozonic group with a single atom of active oxygen.

The manner in which the product of the action of concentrated sulphuric acid on persulphate of potash behaves with chromic acid, enables us to test this hypothesis in another manner. If this product contained a superoxygenated acid of the type of tetroxide of potassium, it ought to give with chromic acid the same excess of oxygen as with permanganic anhydride. Experiments carried out for this purpose have shown, however, that undiluted Caro's reagent behaves exactly like peroxide of hydrogen with chromic acid; that is to say, that it reduces as much chromic acid and disengages as much oxygen as a solution of peroxide of hydrogen containing the same amount of active oxygen.

Exactly weighed quantities of persulphate of potash, of which the proportion of active oxygen present has been determined previously, were treated in the decomposing vessel of my apparatus with pure concentrated sulphuric acid, and, after the solution of the salt, the product was treated with an excess of chromic solution contained in the burette of the apparatus.

The chromic solution was prepared by dissolving pure chromic acid in pure concentrated sulphuric acid. Its proportion of available oxygen was determined iodometrically. The evolution of oxygen having ceased, the volume of gas liberated was read off on the graduated tube, and the green liquid resulting from the reaction was transferred to a test-glass with the help of 150 c.c. of water, and the unreduced chromic acid estimated therein. The following results were obtained in this manner:—

	Peroxide of hydrogen used.	Chromic oxygen in the reaction.	Oxygen given off.
	M.grms.	M.grms.	M grms.
	22·86	17·01	39·32
	25 04	18·22	43·41
	24 62	17·63	42·38
	22 25	16·21	39·02
Means..	23·69	17·26	41·03
Theory .	H_2O_2	17·77	41·46

We observe that the product of the action of concentrated sulphuric acid behaves, from the quantitative point of view with chromic acid, exactly the same as peroxide of hydrogen. Therefore the hypothesis of the presence of a superoxygenated acid in this product is no longer justified.

As a comparison, Caro's reagent, prepared from the same persulphate and the same sulphuric acid as above, was titrated with permanganic anhydride in sulphuric solution:—

Peroxide of hydrogen used.	Permanganic oxygen in the reaction.	Oxygen given off.
M.grms.	M.grms.	M grms.
23·61	13·91	37·02
22 66	13·42	35·60
24 81	14·90	39·42
Means.. 23·66	14·09	37·34

With H_2O_2 the permanganic anhydride reduced should have given off .. .. 28·18 Oxygen

Excess of oxygen .. .. 9·16 ,,

Theoretical volume : volume found : : 1 : 1·32

Thus, the titration of undiluted Caro's reagent by means of permanganic anhydride has given again the same excess of oxygen as in the earlier experiments.

How can we explain the occurrence of this excess of oxygen?

The experiment with chromic acid having proved that it cannot be attributed to the presence of a superoxygenated acid containing more oxygen unstably combined than peroxide of hydrogen, we can only admit that the reaction between the permanganate and the peroxide takes a different course in sulphuric solution than in aqueous solution.

In this latter case, for each atom of available oxygen in the permanganate, 1 molecule of peroxide enters into the

reaction. If we take account of the excess of oxygen mentioned above, it seems probable that in sulphuric solution for each atom of available oxygen there is a reduction of 1⅔ molecules of peroxide. From this it results that while the reaction in aqueous solution corresponds to the proportion,—

Permanganic oxygen : peroxide oxygen = 1 : 1,

the reaction in sulphuric solution takes place according to the proportion,—

Permanganic oxygen : peroxide oxygen = 3 : 5,

As to the chemical nature of Caro's reagent, it is certain that in the dilute condition it possesses other properties than in the undiluted state. In the first case, it does not react on permanganic, chromic, or titanic acids. In the second case, it attacks these reagents very energetically in the same manner as peroxide of hydrogen. It is not very probable that the presence of water is able to cause these differences of properties.—*Moniteur Scientifique*, February, 1903, Series 4, vol. xvii.

TETROXIDE OF HYDROGEN AND OZONIC ACID.

By A. BACH.

During my research on the slow oxidation of the nascent hydrogen given off by hydride of palladium (*Moniteur Scientifique*, 1897, p. 479), I observed a few analytical facts which appear to be explained best by the hypothesis of the formation of a tetroxide of hydrogen. This tetroxide might result from the union of two incomplete groups, H.O.O. and O.O.H., and it ought to decompose according to the equation $H_2O_4 = O_3 + H_2O$, into ozone and water, and for this reason have a more energetic oxidising action than the binoxide of hydrogen.

Later on (*Moniteur Scientifique*, 1900, p, 424), I endeavoured to establish the existence of the tetroxide of hydrogen experimentally. By decomposing tetroxide of potassium by dilute sulphuric acid kept at a very low temperature, I obtained a very unstable solution of peroxide, which, when titrated with permanganate of potash, gave an excess of 30 to 50 per cent of oxygen, more than the amount of permanganate used ought to have given off with binoxide of hydrogen. In all probability I actually had here the hypothetical tetroxide of hydrogen that should be formed by tetroxide of potassium under the action of sulphuric acid, exactly as, for example, binoxide of sodium gives rise to the binoxide of hydrogen:—

$$Na_2O_2 + H_2SO_4 = Na_2SO_4 + H_2O_2.$$
$$K_2O_4 + H_2SO_4 = K_2SO_4 + H_2O_4.$$

Quite recently, Messrs. Baeyer and Villiger have published (*Berichte*, 1902, vol. xxxv., p. 3038) a note on "Ozonic Acid," which is very closely connected with the research I have just mentioned. By passing a current of ozonised oxygen over caustic potash in powder, they obtained an orange-brown product to which they gave the name ozonate of potash, and which they looked upon provisionally as identical with tetroxide of potassium. The same body also appears to be formed when we pass a current of ozonised oxygen through potash-lye kept at a very low temperature. The free "ozonic acid" corresponding to ozonate of potash would be, according to Messrs. Baeyer and Villiger, the hydrate of ozone, $O_3 + H_2O = O_4H_2$.

It is easily seen that Messrs. Baeyer and Villiger's ozonic acid is nothing else than the tetroxide of hydrogen which was the object of my research. In fact, like the binoxide of hydrogen, tetroxide of hydrogen ought to possess acid properties and form well-defined salts. Of these salts we know already tetroxide of potassium and tetroxide of rubidium. But it is probable that the product obtained by Messrs. Baeyer and Villiger is not tetroxide of potassium—judging from its manner of formation—but a product of the addition of 1 molecule of caustic potash to 1 molecule of ozone; that is to say, the acid salt of tetroxide of hydrogen, $KOH + O_3 = KO_4H$.

If this supposition is confirmed, the analogy between the salts of binoxide of hydrogen and those of tetroxide of hydrogen would be complete.

H.O.O.H.	H.O.O.O.O.H.
Na.O.O.H.	K.O.O.O.O.H. (?)
Na.O.O.Na.	K.O.O.O.O.K.

From what has been said, it follows that the term "ozonic acid" must not be looked upon as synonymous with tetroxide of hydrogen.—*Moniteur Scientifique*, Series 4, vol. xvii., p. 106.

THE PREPARATION OF BENZOYL-ACETYL PEROXIDE AND ITS USE AS AN INTESTINAL ANTISEPTIC IN CHOLERA AND DYSENTRY.*

By PAUL C. FREER, M.D., Ph.D.

In a paper published in the *American Chemical Journal* (vol. xxvii., p. 163), a method was described of preparing benzoyl-acetyl peroxide in any desired quantity and chemically pure.

Bacteriological investigation with the solutions of this peroxide in water have shown it to be intensely active as a germicide. One part of the hydrolysed substance in 177 parts of water, and containing only 0 05 per cent of active oxygen, destroys all germs, including spores, almost instantly, and even at a dilution of 1 to 3000, vegetating germs are killed, as a rule, within one minute, but the spores require an appreciably longer time. On comparing these results with similar ones with hydrogen peroxide at 1 to 1000, and phenol at 5 per cent, it was shown that hydrogen peroxide, although it contained ten times as much active oxygen as the solution of benzoyl-acetyl peroxide, was by no means as effective, and the same may be said of phenol.

Experiments showed that solutions of benzoyl-acetyl peroxide as dilute as 1 part in 10,000 absolutely destroy the comma bacillus when it is placed in them in fairly large quantities on the loop of a platinum wire, and growth was prevented, or at least was extremely slow, when the dilution was 1 in 30,000.

It has been demonstrated by means of experiments on dogs that benzoyl-acetyl peroxide can be given internally with success and without damage, and therefore, theoretically, it should be of the greatest value as an intestinal antiseptic.

Chemically considered, benzoyl-acetyl peroxide may be regarded as hydrogen peroxide in which one half of the hydrogen has been substituted by the benzoyl group, and the other half by acetyl. It can be considered, therefore, as the benzoylester of aceto-peracid, or as the acetylester of benzo-peracid, and as such it is subject to hydrolysis or saponification. Experiments by the author and Mr. F. G. Novy showed that benzoyl-acetyl peroxide is in itself inert, and that its activity as an oxidising substance and as a germicide only appears after it has been subjected to hydrolysis by means of water. When the substance is hydrolysed, the reaction consists of the formation of aceto-peracid, which remains in solution, and dibenzoyl peroxide, which is precipitated as a crystalline insoluble powder, and which can be filtered from the clear solution. The germicidal effect of the solution therefore depends upon the presence of aceto-peracid, together with small quantities of benzo-peracid.

In giving capsules of solid benzoyl-acetyl peroxide, this same hydrolysis will take place in the intestines, and the

* Abridged from the "Report of the Bureau of Government Laboratories," Manila, 1902.

resulting germicidal aceto-peracid will have its local effect. Dibenzoyl peroxide has been proved to be practically inert, probably owing to the great difficulty with which it is hydrolysed.

An attempt having been made to obtain a shipment of benzoyl-acetyl peroxide in good condition from America, and having resulted in failure, an attempt was made to prepare it on the spot (in the Philippine Islands), and a shipment of 10 kilos. each of benzaldehyde and acetic anhydride was obtained from Germany.

It soon became apparent that oxidation took place more rapidly at room temperatures common in Manila than it did in the United States; the yield is, however, somewhat impaired, as a larger proportion of dibenzoyl peroxide appears to be produced in this climate than is the case in America, but, nevertheless, the results were sufficiently satisfactory to warrant the construction of a larger apparatus in which 3 kilos. at a time could be worked up by means of a forced current of air.

After complete oxidation the crude product is placed in large tubulated vessels, covered with petroleum ether, and allowed to stand overnight, by which means the larger portion goes into solution. The extracted peroxide and solvent are then tapped off at the bottom, fresh liquid added, and the operation repeated a second time. The united solutions are then carefully concentrated on a water-bath, the temperature of which must not exceed 80°, until about one-third has been distilled off, after which the vessels are placed in the cold room in an ice plant. Crystals of benzoyl-acetyl peroxide, contaminated with some dibenzoyl peroxide, gradually separate, and are eventually filtered off and dried; re-crystallisation from petroleum ether was resorted to subsequently in order to obtain the substance in a pure state. In all 2750 grms. of benzoyl-acetyl peroxide were obtained. At first the hospitals were supplied with double gelatin capsules containing 0·3 grm. of benzoyl-acetyl peroxide each, but later it was found expedient to substitute a somewhat smaller dose of 0·25 grm. to be given more frequently, the best results being finally obtained by the use of the latter, after coating with two layers of celloidin.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Wednesday, February 18th, 1903.

Prof. J. Emerson Reynolds, Sc.D., F.R.S., President, in the Chair.

Mr. J. P. Millington was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Robert Gordon Bibby, New College, Oxford; Thomas Devine, M.B., C.M., 11, Spencer Place, Leeds; Archibald Louis Robinson, B.A., 40, Trinity College, Dublin; Montague White Stevens, 2, Richmond Place, London, S.W.

It was announced that the following changes in the Officers and Council were proposed by the Council:—

As President—Prof. Tilden, F.R.S., *vice* Prof. J. Emerson Reynolds, F.R.S.

As Treasurer—Dr. Horace T. Brown, F.R.S., *vice* Prof. Tilden, F.R.S.

As Secretary—Prof. Wynne, F.R.S., *vice* Prof. Dunstan, F.R.S.

As Vice Presidents—Prof. Dunstan, F.R.S., and Mr. David Howard, *vice* Prof. Divers, F.R.S., and Dr. Stevenson.

As Ordinary Members of Council—Dr. J. T. Hewitt, Dr. C. A. Kohn, Dr. E. J. Mills, F.R.S., and Dr. S. Ruhemann, *vice* Mr. H. B. Baker, F.R.S., Dr. Chattaway, Prof. Clowes, and Dr. Lewkowitsch.

Dr. Hewitt, Dr. Thorne, and Dr. Orton were appointed to audit the Society's accounts.

International Congress of Applied Chemistry.

By direction of the Council, the following letter was read announcing the formation of a Joint Organising Committee in this country in connection with the International Congress of Applied Chemistry which is to be held in Berlin next June.

Society of Chemical Industry,
Palace Chambers, 9, Bridge St., Westminster,
London, S.W., February 10th, 1903.

"*International Congress of Applied Chemistry, Berlin.*"

Dear Sir,—I am directed to inform you that at the conference held at this office on the 6th inst. and referred to in my letter of the 26th ult., the following resolutions were passed:—

1. That the delegates appointed by the Royal Society, Chemical Society, and Society of Chemical Industry, to represent these Societies at the International Congress of Applied Chemistry to be held in Berlin in June next, agree to form the joint Organising Committee contemplated in the letter of May 30th last from the President of the Organising Committee at Berlin.

2. That the Organising Committee so formed invites the co-operation of the other Learned and Industrial Societies in Great Britain, whose members are interested in Applied Chemistry.

3. That the President of the Society of Chemical Industry be requested to act as Chairman of this Organising Committee.

4. That Mr. C. G. Cresswell be requested to act as Secretary *pro tem.*

5. That a copy of these resolutions be communicated to Dr. Otto Witt, President of the Congress.

I remain, your obedient servant,
(Signed) Chas. G. Cresswell.

The Secretary, Chemical Society.

The following delegates have been appointed by the Council to represent the Chemical Society at the Congress:—Prof. Tilden, Prof. Dunstan, Prof. W. H. Perkin, jun., and Dr. A. Scott.

Fellows of the Society who propose to attend the Congress next June are requested to send their names to the Secretaries, so that they may be communicated to the Organising Committee in Berlin.

A ballot for the election of Fellows was held, when the following were subsequently declared duly elected:—Gilbert John Alderton; George Henry Appleyard; Edwin Bayles Atkinson; K. Bhaduri, M.A.; William Bowen; Samuel Bradbury; George Thomas Branch; Hubert William Bywaters, Ph.D.; William Henry Cadman; John Castell-Evans; Arthur John Codling; Francis George Cousins; Benjamin Claxton Coyle; Cecil Henry Desch, Ph.D., D.Sc.; Archibald Sefton Elford, B.A.; Robert Crosbie Farmer, M.Sc., Ph.D.; Leonard King Hindmarsh, B.A.; Franklin Wise Howorth; Moung Tha Huyin, B.A.; Maurice Kemp-Welch, B.A.; Frederic Herbert Lees; Arthur Graham Leigh; Harry Percy Lewis; Percy George Mander, B.Sc.; Frederick O'Brien, M.Sc.; George Montague Prichard; Thomas Samuel, B.A.; Alfred H. Scholefield, B.A., B.Sc.; Samuel Edward Sibley; Alec Bowring Steven, B.Sc.; George Malcolm Thomson; Charles Tilburn; Stanley Tolson; Francis Digby Toyne; Duncan Turner; John Mello Wadmore, B.A.; Thomas Crosbie Walsh; David John Williams; Albert Wilmore; William Wade Yeomans; Andrew Young, M.A., B.Sc.

Of the following papers, those marked * were read:—

*24. "*The Molecular Re-arrangement of N-substituted Imino-ethers.*" By G. D. Lander.

The re-arrangement of the atomic grouping ·C(OR):N· into ·CO·NR· may be effected catalytically (Knorr and Wheeler) or by heating (Wislicenus), and both kinds of

isomerisation have been studied with some of the recently prepared N-substituted imino-ethers.

Alkyl iodides prove more useful in the catalytic re-arrangement than bromides or chlorides, and the isomerisation by means of iodides has been examined with the following imino-ethers:—N-phenylacetimino-methyl- and -ethyl, N-*o*-tolyl- and N-*p*-tolylacetimino-ethyl, N-phenylbenzimino-methyl and -ethyl, N-*o*-tolyl- and N-*p*-tolylbenzimino-methyl and -ethyl, N-methylbenzimino-methyl and -ethyl, N-ethylbenzimino-methyl and -ethyl, and N-benzylbenzimino-methyl- and -ethyl.

Isomerisation occurs more readily with the methyl than with the ethyl compounds, the former, for the most part, undergoing re-arrangement at 100°, a temperature at which there is very little change with the latter. The ease of transformation also depends on the orientation of the aryl group attached to nitrogen, *p*-tolyl changing more easily than *o*-tolyl compounds.

The following substituted amides which result from the isomeric change do not appear to have been previously described:—*Benzmethyl-o-tolylamide* (m. p. 65—66°) crystallises in prisms from ether and light petroleum; *benzethyl-o-tolylamide* melts at 71—72°; *benzmethyl-p-tolylamide* and *benzethyl-p-tolylamide* form prisms melting at 46—48° and 38—40° respectively; *benzmethylbenzylamide* and *benzethylbenzylamide* are liquids boiling respectively at 213—214° (11 m.m.) and 214—216° (12 m.m.).

The re-arrangement by heat occurs far less readily. N-phenylacetimino-methyl ether undergoes partial isomerisation on prolonged boiling, and considerable isomeric change of N-methylbenzimino-methyl ether was obtained after nine hours' heating at 250—270°. With N-phenylbenzimino-methyl ether (*Ber.*, 1900, xxxiii., 1470), less conclusive results were got. With ethyl-imino-ethers, the main change produced by prolonged heating is the elimination of ethylene and re-generation of the parent amide. It is therefore doubtful whether the isomerisation can be caused by simple heating.

Attention was drawn to the formation of ethyl paracyanoformate, $(CN\cdot CO_2Et)_x$, from diethyl imino oxalate, $HN{:}C(OEt)CO_2Et$, by loss of alcohol and subsequent polymerisation.

Discussion.

Dr. Orton asked whether Dr. Lander had brought about the isomeric change of an O-iminoether into the N-alkyl compound by use of an alkyl iodide, in which the alkyl group was not identical with the alkyl group of the imino-ether. If the first stage of the change is the formation of an additive product of the alkyl iodide and the iminoether, then, if sufficient quantity of the alkyl iodide be used, a N-alkyl derivative should be obtained, which would possess the alkyl group of the alkyl iodide, and not that originally present in the O-iminoether.

Dr. Lander, in reply, stated that he had performed an experiment in which the catalytic action of normal propyl iodide (1 mol.) on a methyliminoether had been found to yield chiefly substituted methylamide, the corresponding propyl compound being also produced, but to a less extent, the trace of methyl iodide first formed proving more effective than the relatively large amount of higher iodide also present.

*25. "*The Nature and Probable Mechanism of the Replacement of Metallic by Organic Radicles in Tautomeric Compounds.*" By G. D. Lander.

The results of the alkylation of keto-enolic compounds and substituted amides by means of dry silver oxide and alkyl iodides (*Trans.*, 1900, lxxvii., 729); 1901, lxxix., 690; 1902, lxxxi., 591; *Proc.*, 1901, xvii, 59) were discussed in the light of the addition hypothesis and its modifications, and also with reference to the views on the mechanism of the replacement of metallic radicles in tautomeric compounds as developed by Wislicenus ("Tautomerie," *Ahrens-Sammlung*, 1897, 249). The opinion was advanced that none of these hypotheses is competent to give a perfectly general elucidation of the phenomena, and an explanation was therefore sought in the hypothesis of the display of tautomeric relationships by the compounds containing metallic radicles.

In order to test the validity of silver oxide alkylation as a basis for the discussion of the mechanism of this replacement of metallic radicles, the alkylation of ethyl oxaloacetate and formophenylamide by this method was investigated. The former yields ethyl ethoxyfumarate on treatment with silver oxide and ethyl iodide, a result agreeing with that obtained by Nef (*Annalen*, 1893, cclxxvii., 73); the latter, on methylation with silver oxide, gives chiefly N-phenylformiminomethyl ether, $NPh{:}CH\cdot OMe$, together with small amounts of formophenylmethylamide, $CHO\cdot NMePh$, and diphenylformamidine. The production of the last two substances does not appear to have been noted in the methylation of silver formophenylamide by Comstock and Kleeberg (*Am. Chem. Journ.*, 1891, xiii., 514), but a control experiment showed that both are formed in their process to a somewhat greater extent than by the silver oxide methylation.

Methylation of the substituted amides by means of silver oxide leads to the formation of mixtures of imino-ethers and isomeric substituted amides, ethylation of these amides under similar conditions apparently gives rise exclusively to imino-ethers. When, however, the ethylation of acetophenylamide by means of silver oxide is conducted in a closed vessel at 100°, N-phenylacetimino-ethyl ether, $NPh{:}CMe\cdot OEt$, and the isomeric amide, $NEtPh\cdot CMeO$, are both produced, just as isomerides are formed in the methylation of the same amide in open vessels at the ordinary temperature or at 40—50°.

N-phenylbenziminomethyl ether, $NPh{:}CPh\cdot OMe$, does not undergo isomeric change when boiled in benzene solution for four hours with dry silver oxide and methyl iodide.

*26. "*The Chlorine Derivatives of Pyridine.* Part VIII. *The Interaction of* 2 : 3 : 4 : 5-*Tetrachloropyridine with Ethyl Sodiomalonate.*" By W. J. Sell and F. W. Dootson.

The chief product of the interaction of 2 : 3 : 4 : 5-tetrachloropyridine and ethyl sodiomalonate is ethyl 2 : 3 : 5-trichloropyridyl-4-malonate, which, on hydrolysis, loses carbon dioxide, yielding 2 : 3 : 5-trichloropyridyl-4 acetic acid. The latter compound is non-volatile, and when heated a little beyond its melting-point, is quantitatively decomposed into 2 : 3 : 5-trichloro-4-methylpyridine and carbon dioxide. On oxidation with potassium permanganate, 2 : 3 : 5-trichloro-4-methylpyridine yields the corresponding acid. These changes may be thus represented:—

$$C_5NHCl_3\cdot CH(CO_2Et)_2 \rightarrow C_5NHCl_3\cdot CH_2\cdot CO_2Et \rightarrow C_5NHCl_3\cdot Me \rightarrow C_5NHCl_3\cdot CO_2H.$$

*27. "*The Biological Method for Resolving Inactive Acids into their Optically Active Components.*" By A. McKenzie and A. Harden.

In much of the research in this field, no attempt has been made to work with pure cultures. Hence, although the optically active products desired in certain cases were successfully obtained, there is often doubt as to the exact organism by which the resolution had actually been effected, the object having been to obtain the pure active isomeride rather than to examine the action of any particular organism on the inactive acid, and therefore many resolutions ascribed to *Penicillium glaucum* have probably been accomplished, not by that mould, but by bacteria with which the solution under investigation had accidentally become contaminated (compare Landolt, "Das Optische Drehungsvermögen," 1898, 63).

The authors have investigated the action of *Penicillium glaucum*, Link; *Sterigmatocystis nigra*, van Tieghem (= *Aspergillus niger*, van Tieghem, *olim*); and *Aspergillus griseus*, Link, and their action on racemic, dimethoxy-succinic, lactic, α-ethoxypropionic, α-propoxypropionic, α-hydroxybutyric, β-hydroxybutyric, glyceric, malic, methoxysuccinic, ethoxysuccinic, propoxysuccinic, man-

delic, methoxyphenylacetic, ethoxyphenylacetic, propoxyphenylacetic, α-bromopropionic, α-bromobutyric, chlorophenylacetic, and monobromosuccinic acids and alanine were investigated.

Their experiments tend to show that the mode of action of the moulds is such that the one active isomeride is attacked more readily than the other, and that the extent of the resolution depends solely on the difference of this rate of attack. The view generally held, namely, that the one isomeride is attacked whilst the other remains untouched, does not appear to be correct. Two other points were kept in view: firstly, whether, from the action of organisms, any definite relationship could be established as to the configuration of the various related acids; and, secondly, whether the active products of the action of different organisms on the same series of acids show any regularity as to sign of rotation.

28. "*Colour Changes observed in Solutions of Cobalt Chloride.*" By W. N. HARTLEY.

A paper by Donnan and Bassett (*Trans.*, 1902, lxxxi., 939) contains a reference to some work on the action of heat on the absorption spectra and chemical constitution of saline solutions, and to this (*Sci. Trans. Roy. Dublin Soc.*, 1900 [7], 253) the author takes exception, as being misleading in certain important particulars.

The characteristic spectra of aqueous solutions of cobalt chloride saturated at 20°, as seen in wedge-shaped cells at temperatures between 23° and 93°, differ from those of the hydrochloric acid solution; the compound formed at 93—100° in neutral solutions seems to be the dihydrate, $CoCl_2,2H_2O$, and not the anhydrous salt.

The solution in hydrochloric acid probably contains a compound of the salt with the acid, for the spectrum is peculiar; and, moreover, the anhydrous salt, which is insoluble in dry ether, dissolves in this medium when the mixture is treated with carefully dried hydrogen chloride.

Pure cobalt sulphate may be heated to 300° without perceptible change, and does not alter at a temperature approaching 800°.

Zinc chloride added to a solution of cobalt chloride prevents the development of the blue colouration on warming; this action may be explained by assuming the formation of a double chloride which does not give rise to the dihydrate. The changes produced by mercuric chloride on an alcoholic solution of cobalt chloride are due to the formation of the double cobalt mercuric chloride (Claudet's salt), a substance which in the solid state is particularly sensitive to changes of temperature. If the blue solution observed by Donnan and Bassett during the electrolysis of cobalt chloride is due to the formation at the anode of a complex ion, it should be possible to separate and analyse solutions containing these ions, and so determine the ratio of cobalt to chlorine.

The hypothesis that hydrated salts can exist in highly concentrated solutions, and can undergo dissociation on raising the temperature, accounts precisely for the phenomena observed not only in the case of cobalt chloride, but also in that of its iodide, bromide, and the salts of other metals.

29. "*The Action of Ammonia and Organic Bases on Ethyl Esters of Olefinedicarboxylic and Olefine-β-ketocarboxylic Acids.*" By S. RUHEMANN.

Ethyl benzylidenemalonate condenses with benzamidine to form *ethyl dihydrodiphenylpyrimidonecarboxylate* (m. p. 188°) according to the equation—

$$CHPh:C(CO_2Et)_2+CPh(NH_2):NH=$$
$$=CHPh<\begin{matrix}CH(CO_2Et)\cdot CO\\ NH\text{ ——— }CPh\end{matrix}>N+C_2H_6O.$$

When this compound is treated with ammonia the ring opens and then closes, with the loss of carbon dioxide and alcohol, forming *dihydrodiphenylpyrimidone* (m. p. 180°), $CHPh<\begin{matrix}CH_2—CO\\ NH\cdot CPh\end{matrix}>N$, which is also formed by the action of benzamidine on ethyl benzylideneacetoacetate in accordance with the following equation:—

$$CH_3\cdot CO\cdot C(CO_2Et):CHPh+CPh(NH_2):NH+C_2H_6O=$$
$$=CH_2<\begin{matrix}CO_2Et\quad NH\\ CHPh—NH\end{matrix}>CPh+CH_3\cdot CO_2Et=$$
$$=CH_2<\begin{matrix}CO\text{ ——— }N\\ CHPh\cdot NH\end{matrix}>CPh+CH_3\cdot CO_2Et+C_2H_6O.$$

In studying the action of ammonia on ethyl esters of olefine-β-ketocarboxylic acids, it was found that both ethyl ethylideneacetoacetate and ethyl furylideneacetoacetate are transformed by ammonia into ethyl hydrocollidinedicarboxylate and ethyl hydrofuryllutidenedicarboxylate respectively. The formation of these compounds depends on the previous decomposition of the ethyl olefine-β-ketocarboxylic ester into ethyl acetoacetate and the aldehyde ammonias, which, in turn, condense to form the hydrogenised pyridine derivatives.

Ethyl benzylideneacetoacetate,—

$$CH_3\cdot CO\cdot C(CO_2Et):CHPh,$$

behaves differently towards ammonia, and yields *benzylideneaminoacetone*, $CH_3\cdot CO\cdot C(NH_2):CH\cdot C_6H_5$ (colourless needles, m. p. 125°). This substance, on heating with acids, readily loses benzaldehyde. On carefully warming the ketone with concentrated hydrochloric acid, an insoluble chloride is produced which may be regarded as diacetobenzylideneimide hydrochloride, $NH(CAc:CHPh)_2,HCl$.

30. "*Derivatives of* p-*Aminoacetophenone.*" By K. D. CHATTAWAY.

In the course of a study of the transformation of diacetanilide into aceto-*p*-aminoacetophenone under the influence of hydrogen chloride or of zinc chloride, the following compounds have been prepared. They are formed by the ordinary processes, but in the preparation of the nitrogen-halogen derivatives great care must be taken to avoid the liberation of free halogen, otherwise substitution in the ketonic chain occurs.

p-*Acetylchloroaminoacetophenone*, $C_6H_4Ac\cdot NAcCl$, colourless, pearly plates, readily soluble in chloroform, m. p. 72°; p-*acetylbromoaminoacetophenone*, $C_6H_4Ac\cdot NAcBr$, yellow, rhombic plates, m. p. 83°; p-*propionylaminoacetophenone*, $C_6H_4Ac\cdot NH\cdot COEt$, colourless prisms, m. p. 136°; p-*propionylchloroaminoacetophenone*, $C_6H_4Ac\cdot N(COEt)Cl$, colourless plates, m. p. 42°; p-*benzoylaminoacetophenone*, $C_6H_4Ac\cdot NH\cdot COPh$, thin colourless plates, m. p. 205°; p-*benzoylchloroaminoacetophenone*, $C_6H_4Ac\cdot N(COPh)Cl$, colourless plates, m. p. 77°.

On heating, the nitrogen-halogen derivatives undergo transformation with considerable decomposition; when dissolved and warmed in acetic acid, halogen passes from the nitrogen into the ortho-position in the nucleus, whilst, if free halogen is liberated, substitution in the methyl group of the ketone also takes place.

Anniversary Dinner.

It has been arranged that the Fellows of the Society and their friends shall dine together at the Whitehall Rooms, Hotel Métropole, at 6.30 for 7 o'clock, on Wednesday, March 25th, 1903 (the day fixed for the Annual General Meeting).

PHYSICAL SOCIETY.

Ordinary Meeting, February 27th, 1903.

Dr. R. T. GLAZEBROOK, F.R.S., President, in the Chair.

A PAPER by Prof. FLEMING and Mr. CLINTON "*On the Measurement of Small Capacities and Inductances*" was read by Prof. FLEMING.

The measurement of small capacities and inductances has become important in connection with Hertzian Wave Wireless Telegraphy. For the measurement of small capacities, when the dielectric is air or some other sub-

stance not possessing the quality commonly called absorption, no method is so easy to apply as that depending upon the rapid charge and discharge of a condenser through a galvanometer. This method has been extensively employed, the only difference being in the nature of the commutator for charging and discharging the condenser. The authors of the paper have had considerable experience with tuning-fork devices for commutating, but have found them troublesome in practice. They have therefore designed a rotating commutator which renders the measurement of small capacities a matter as easy as the measurement of resistance on a Wheatstone bridge. The appliance is described in the paper, and the authors claim that they have worked out a thoroughly satisfactory form of rotating commutator, designed more from the point of view of an engineer than an electrical instrument maker. For use with the instrument a moving-coil differential galvanometer has been designed. The magnetic field at either of the coils can be varied by means of a piece of soft iron which can be moved about in the field. By using a differential galvanometer the method can be reduced to a null one and made independent of a knowledge of the E.M.F. employed in the experiments. The authors have made a number of experiments upon the capacity of aërial wires, such as are used in Hertzian Wave Telegraphy, and have also investigated the laws governing the capacity of such wires when grouped together in certain ways, and verified experimentally, as far as possible, the formulæ for the capacity of insulated wires in various positions in regard to the earth. The experiments are given at length in the paper, and the results practically obtained are compared with those derived from theoretical considerations. In all cases the total measured capacity of n wires is less than n times the capacity of one wire. In dealing with small capacities a difficulty arises in connection with the allowance to be made for the capacities of the leads and the commutator. The capacity of an object measured, as it would be in free space, is only obtained to a first approximation by deducting the capacity of the leading wire and commutator from that of the leading wire, commutator, and object. For the measurement of small inductances the authors have constructed an instrument, similar to the secohmmeter of Ayrton and Perry, upon the same lines as their rotating commutator. By making the apparatus substantial and eliminating all insulating material, except air, from the surface of the rotating drums, and abolishing all flimsy spring-contacts, they have produced an apparatus which is much more satisfactory to work with than the ordinary secohmmeter of the instrument-makers. The determinations of inductance were made by Anderson's method.

Prof. AYRTON said he was glad to see that the authors had brought out an apparatus constructed on engineering lines. He mentioned that the secohmmeter used in his laboratory was not the instrument of the instrument-makers' catalogues, but more like the one exhibited. Prof. Fleming had given some account of the history of the subject, and had referred to early experiments carried out by using tuning-forks as commutators. Rotating commutators were, however, in use some time before the introduction of tuning-fork arrangements. The fact that air was superior to mica, ebonite, or other substances as the insulating material at the surface of a rotating commutator had been recognised by Prof. Perry and himself in a patent taken out many years ago. The authors had raised the question of the legitimacy of subtracting the measured capacity of the commutator and leads from the measured capacity of the commutator, leads, and condenser in order to obtain the capacity of the condenser. He pointed out that the results of the experiments described in the paper showed that this procedure was wrong. He asked in what respect Anderson's method of measuring a self-induction was superior to the method of comparing it directly with a standard variable self-induction. Referring to the galvanometer used in the experiments, Prof. Ayrton pointed out that the device of shunting the magnetic flux through a piece of soft iron had been used before. There were two objects in employing such a shunt. In the first case, when using an ordinary moving-coil galvanometer as a voltmeter, it was necessary to keep the sensibility constant, and any alteration in the strength of the magnets could be counterbalanced by a movement of the shunt. In the second case, the shunt was useful in the construction of differential moving-coil galvanometers. Some years ago a series of observations were conducted in his laboratory to determine the errors which might enter into experiments carried out with a rotating commutator, and he remarked that, in order to avoid contact differences of potential, it was essential that the commutator and the brushes should be made of the same material.

Prof. S. P. THOMPSON said the experiments were the first which had been made upon the capacities of wires suspended near each other in air. Referring to the measurement of small capacities Prof. Thompson briefly described a method which he had published similar to Carey Foster's method of comparing two nearly equal resistances. All that is required for accuracy is a known standard capacity and a calibrated sliding condenser.

Mr. A. CAMPBELL exhibited the commutator used for condenser tests at the National Physical Laboratory. It is similar to that designed by Mr. Searle and used by him and Prof. J. J. Thomson in their determination of the value of "v." In this commutator the ebonite insulation does not fill the spaces between the segments, and is never touched by the brushes, thus giving satisfactory insulation. By its aid many measurements have been made of the B.A. air-condensers, the capacity of each of these being about 0·02 m.fd. The galvanometer used was so sensitive that the time-measurement had to be carefully performed to get equal accuracy. In the earlier experiments an ordinary moving-magnet galvanometer was used, but it was discovered that if the magnet at its zero position was not exactly parallel to the planes of the coils, considerable changes occurred in the observed capacities when the battery was reversed. This effect was due to the fact that, with the needle in such a position, the galvanometer could respond to alternating currents, and that its deflection (except when the needle was exactly at right angles to the coil axis) was partly due to the mean current and partly to the square-root mean-square current. When a condenser of $\frac{1}{3}$ m.fd. was put in parallel with the galvanometer the effect practically disappeared. A moving coil galvanometer, however, was found to be quite free from such effects, and this type had been used in nearly all the tests. The differential galvanometer described by the authors appeared admirable, and would be a useful instrument for a number of purposes, a great advantage being that the mutual inductance from coil to coil would be very small.

Mr. JACOB asked Mr. Campbell if he was sure that the movement of the galvanometer-needle mentioned by him was not due to electrostatic effects. He pointed out that if a differential moving coil-galvanometer was correctly balanced for one point of the scale, it did not follow that it would remain balanced at any other point. It was a matter of common knowledge that the total capacity of wires near each other was less than the sum of the capacities of the wires taken separately.

Mr. J. T. MORRIS asked if the authors had any proof that the condenser was perfectly charged and discharged on every occasion. He drew attention to the fact that the capacity might depend upon the form of the wave of potential difference which charged it.

Mr. R. APPLEYARD said that the capacity of a condenser with mica dielectric determined from a single charge and discharge was practically the same as that obtained from several charges and discharges per second. This was not the case with rubber. He asked if the authors had observed differences in capacity depending upon the point of attachment of the leading wire.

Mr. W. C. CLINTON, in reply, said they had used

Anderson's method because they found it more convenient than any other. It required no arbitrary standard of inductance or determination of speed, the only things required being resistance-boxes and a known capacity. They had obtained different capacities for wires by varying the point of attachment of the lead, the maximum variation amounting to about 5 per cent of the total capacity.

A paper "*On the Thickness of the Liquid Film formed by Condensation at the Surface of a Solid*," was read by Dr. G. J. Parks.

It was known more than half a century ago that when a solid is placed in a gas or vapour there is a condensation of the latter on the surface of the solid, and in particular that glass has the power of condensing water-vapour at temperatures above the dew-point. In order to determine the thickness of the liquid film, the author has exposed masses of cotton-silicate of known area to the action of water-vapour. From the increase in weight he has calculated that the thickness of the film is $13{\cdot}4 \times 10^{-6}$ cms. The cotton-silicate thus covered with a film of moisture showed no alteration in appearance even when examined under the highest power of the microscope, but when the silicate was placed in water, no heat was evolved. It may therefore be inferred that the Pouillet effect for water in contact with glass at about 12° C. is confined to a film of moisture, the thickness of which is about $13{\cdot}4 \times 10^{-6}$ cms. The Author has compared his results with those obtained by other experimenters with different substances and under widely different conditions, and concludes that in all cases where condensation of moisture takes place at a solid surface, and at temperatures not below the dew-point, the thickness of the surface-film varies from 10×10^{-6} to 80×10^{-6} cms., according to the substances used and the conditions of temperature and pressure.

Prof. Everett remarked that similar experiments upon different kinds of glass had been carried out by Kohlrausch. The glass, in the form of powder, was placed in a platinum dish under a bell-jar exposed to water vapour. The increases in weight varied from 2 per cent to 18 per cent, whereas the increase observed by Dr. Parks was only 1·2 per cent.

Prof. S. P. Thompson congratulated the Author upon the results of his experiments, but advised him to be cautious in using them in any attempt to determine the law of molecular attraction. Similar experiments were carried out in Bunsen's laboratory about twenty years ago.

Dr. J. A. Harker said that the liquid film on the surface of glass or porcelain was often a source of trouble in high temperature gas thermometry. He had found that in exhausting Röntgen-ray tubes it was apparently possible to get a complete vacuum at about 300° C., but on heating to a slightly higher temperature gases were given off from the walls of the tubes.

Mr. J. Brown, in a communication to the Secretary, stated that the paper recalled an investigation of his own undertaken with quite a different object, viz., the question as to whether the condensed films on plates of copper and zinc could be brought into contact so as to form the electrolyte of a voltaic cell and produce a current. The limit of separation of the plates at which the current ceased was measured very roughly, and came out considerably greater than that observed by Dr. Parks. It may be possible that the electrically conducting film has a much less specific gravity than ordinary water.

Dr. P. E. Shaw, in a communication to the Secretary, stated that in the Author's experiments, and in most of those referred to, the radius of curvature of the solid surface was small, and was in fact comparable with the thickness of the film deposited on it. It would be interesting to try the effect on flat surfaces, and also at temperatures below 0° C. He had observed the film on fine wires, which, brought into contact crossing at right angles, adhere with the force of the order of a dyne. Dr. Shaw had used the Author's value for the thickness of the film to explain the results obtained in 1901 by Mr. Earhart on the voltages required for sparking between surfaces when the distance between them is small. The dust particles in air have an enclosing film thick enough to contain and foster any of the well known bacilli.

The Chairman said the results were of particular interest to him, because he was at present engaged in making mercury standards of resistance. In his experiments it was necessary to measure the radii of the tubes with an accuracy comparable with the thickness of the liquid film.

Dr. Parks, in reply to Dr. Harker, said that powdered silica might be heated to 300°, and appear quite dry. On heating it slightly higher, however, large numbers of bubbles were given off suddenly, and the powder resembled a boiling liquid.

NOTICES OF BOOKS.

The Principles of Animal Nutrition; with Special Reference to the Nutrition of Farm Animals. By Henry Prentiss Armsby. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1903. Pp. viii.-614. 8vo.

This scholarly work is the product of one whose training and experience have well qualified him for its preparation. Dr. Armsby is well known as the Director of the Pennsylvania State College Agricultural Experiment Station, as well as Expert in Animal Nutrition, United States Department of Agriculture. The substance of the volume was given in the form of lectures before the Graduate Summer School of Agriculture at the Ohio State University in 1902.

Activity in the study of the problems of animal nutrition during the last quarter of a century has resulted in regarding these problems from a new point of view; to more accurate knowledge of the chemistry of nutrition has been added "a clear and fairly definite general conception of the vital activities as transformations of energy and of the food as essentially the vehicle for supplying that energy to the organism."

This volume presents in systematic form the fundamental principles of animal nutrition from the modern standpoint of energy relations, with special reference to farm animals; it is therefore on a higher plan than a mere treatise upon stock-feeding. Part I. deals with the income and expenditure of matter, in six chapters, the Food, Metabolism in its many phases, and its relation to food supply, and as affected by muscular exertion. Part II. treats of the income and expenditure of energy in thirteen well-studied chapters, the whole forming a compendium of great value and interest. No earnest student of the topics discussed in the pages of Dr. Armsby's work can afford to ignore it.

Many footnotes give the sources of the statements made in the text, but the reviewer regrets that the author in referring to periodicals has failed to add to the volume number, the date of issue; the value of a citation may often be weighed by knowing its date, an item which the reader cannot, as a rule, take time to supply.

The book is well made and printed; it has an uncommonly full index. It is pleasant to handle a new book that opens and lies flat. H.C.B.

The Chemistry of Indiarubber; Including the Outlines of a Theory on Vulcanisation. By Carl Otto Weber, Ph.D. With Four Plates and several Illustrations in the Text. London: Charles Griffin and Co., Ltd. 1902. Pp. 314.

The analysis of indiarubber was very little understood ten years ago; in fact, most of the work in this direction

has been done during the last decade. But as a mere compilation of analytical methods would have been only of technical interest, the author has wisely decided to extend the scope originally intended for this volume, and has written an important chapter on the "Chemistry of India-rubber"; this forms Chapter I., and covers 115 pages.

Indiarubber, as is well known, is the product of the coagulation of the milky juices of a large number of trees, comparable to the oils, and more especially to the terpenes. Certain sugars, such as inosite, bornesite, and matezite, are present in indiarubber, and can be removed by washing with water. After washing and drying, the substance left forms technically pure rubber, but it is by no means chemically pure, as several oily and resinous substances can be extracted by means of certain solvents, such as alcohol or acetone. The elementary composition of indiarubber has been found by several authorities to be $C_{10}H_{16}$, and this is now generally taken to be correct, although Henriques has pointed out within recent years the possibility that indiarubber might be after all an oxygen compound.

Indiarubber in the highest state of chemical purity is a practically colourless substance, and its physical properties are of considerable interest; its distensibility increases considerably with an increase of temperature, and on cooling down to the temperature of liquid air Professor Dewar showed recently at the Royal Institution that even a thin sheet of rubber becomes sufficiently hard and rigid to withstand the pressure of a Torricellian vacuum, though it is at the same time exceedingly brittle.

Chapter III., on the examination of rubber substitutes, as well as the five following ones, is of technical interest, These chapters deal with "Inorganic Compounding Materials," "Vulcanisers and Sulphur Carriers," "India-rubber Solvents," "Colouring Matters," and "The Constructive Components of Indiarubber Articles."

Chapter IX. is an important one, on the analysis of indiarubber articles; in it are enumerated physical, mechanical, and electrical tests; the chemical analysis of rubber, and analytical methods. The analysis of hard rubber goods, such as ebonite, is also dealt with; while the interpretation of results receives due attention.

There is an appendix on sanitary conditions in india-rubber works, a subject index, and one for authors' names.

This volume is a valuable contribution to the rather scanty scientific literature of indiarubber, and as it points out in what directions researches should be made, and where improvements are likely to be possible, it should be of much service to manufacturers and others connected with the indiarubber industry.

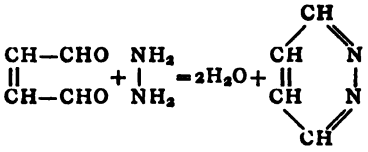
CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 6, February 9, 1903.

The Displacement of the Sulphuric Acid in the Alkaline Bisulphates by Water.—Albert Colson.—The temperature at which the dilution of a body takes place without variation of temperature is a means of finding out whether an addition of water to a salt solution provokes chemical change. Solutions are taken containing—(1) 142 grms. of neutral sodium sulphate (Na_2SO_4) dissolved in a litre of normal sulphuric acid; (2) the same, diluted with its own volume of water; (3) a solution of one part of potassium bisulphate, $KHSO_4$, and four parts of water; and (4) the last, diluted with its own volume of water. An investigation of these four solutions leads the author to the conclusion that there is a possibility of extracting by the simple action of water a part of the acid from a salt, and utilising this acid for industrial purposes.

A New Synthesis of Orthodiazine.—R. Marquis.—Fumaric or maleic aldehyde should react on hydrazine, giving a cyclic compound containing 2 atoms of nitrogen—the compound orthodiazine, which is already known,—

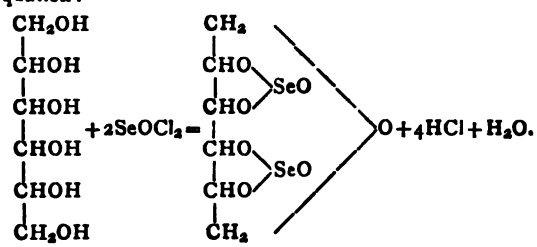


The author's experiments prove that this reaction does take place.

Formation of Azoic Compounds. Reduction of Orthonitrobenzylic Alcohol. — P. Freundler. — The author's experiments show that the reduction of ortho-nitrobenzylic alcohol takes place in quite a special manner. Using the minimum quantity of red acid, the composition of which is not at all certain, products formed during the normal reaction are not produced—such as azoic, hydrazoic, or azoxyic acids. All the bodies which are formed result from the transformation of the nitrated portion of the amine group, by oxidation of the alcoholic part of the aldehydic and acid function, and from condensation of a certain number of primary products with one another—a condensation which gives rise to more complex bodies.

Oxidation of Cobalt and Manganese Acetates by Chlorine.— H. Copaux.— The author finds that the acetates of cobalt and manganese are oxidised by chlorine in different ways. In the first case, a complex chloro-acetic compound of the intermediate oxides Co_3O_4 is formed; and in the second, an acetate of manganese sesquioxide.

Action of Selenyl Chloride on Mannite.—C. Chabrié and A. Bouchonnet.—A previous research treats of the action of selenyl chloride on erythrite, and now the authors extend their investigation to its action on mannite. The reaction apparently takes place according to the following equation:—



The formation of hydrochloric acid, and the temperature of the reaction, explains the dehydration, and the existence of the group SeO is shown by the fact that all the selenium can be precipitated by sulphurous acid when hot in an aqueous solution of the product.

Synthesis of Anisic Acid and Paraethoxybenzoic Acid.—F. Bodroux.—The monobromated derivatives of the phenolic oxides react with magnesium in presence of anhydrous ether. By this means organo-metallic compounds are formed which possess all the properties of chlorides, bromides, and iodides of alcoyl-magnesium. Aldehydes, acetones, ether salts, iodine, and bromine act on these salts with violence; water destroys them, and primitive phenolic oxides are formed. Finally, carbonic anhydride is absorbed, with formation of double salts of magnesium, which decompose acids whilst liberating the ether oxides of phenol acids. An application of this latter reaction to the parabromated derivatives of anisol and phenetol the author uses as a means of synthesising anisic and paraethoxybenzoic acids.

Molecular Decomposition in the Pyrane Series.—R. Fosse.—Under the influence of bromine, naphthylol-dinaphthopyrane, $OH-C_{10}H_6-CH<^{C_{10}H_6}_{C_{10}H_6}>O$, breaks up its trinaphthylmethanic molecule into two bromated molecules, $OH-C_{10}H_6-Br+CH<^{C_{10}H_6}_{C_{10}H_6}>O-Br$.

Migration of the Methyl Group under the influence of Hydriodic Acid.—E. E. Blaise.—Under the influence of hydriodic acid, one of the methyl groups in dimethol glutaconic acid migrates from position 2 to position 4.

A New Orthocyclohexanediol and its Derivatives.—Léon Brunel.—In a preceding research the author describes the preparation of a hexahydrobenzenic glycol from monohydriodic ether. This substance is orthocyclohexanediol, $OH-C_6H_{10}-I$, and the ether oxides, $CH_3O-C_6H_{10}-I$ and $C_2H_5O-C_6H_{10}-I$, of this alcohol. He now examines the products obtained by saponification of these products.

Two New Glucotannoids.—Eugene Gibson.—During an investigation on the tannoids obtained from China rhubarb, the author isolates two new glucotannoids, which he prepares in a pure crystalline state. These he calls glucogalline and tetrarine.

MISCELLANEOUS.

Royal Institution.—A General Monthly Meeting of the Members of the Royal Institution was held on the 2nd inst., Sir James Crichton-Browne, Treasurer and Vice-President, in the Chair. The following were elected Members:—Rev. Charles H. Bowden, Mr. W. Chattaway, Mr. C. Clark, Mr. H. R. Goring, Mr. J. B. Hilditch, Mr. C. E. Kayler, Mrs. Kayler, Mr. J. R. Macdonald, Mr. H. F. Morley, Miss H. Nunes, Lady Russell Reynolds, Mr. J. Rheinberg, Mr. T. K. Rose, Mr. H. H. Shepherd, Mr. J. K. Spence, Mr. F. T. Trooton, Mrs. Vlasto, Mr. J. A. Voelcker, Mr. W. Weddell, Mr. J. W. Western, and Miss E. Willmott. The special thanks of the Members were returned to the Worshipful Company of Clothworkers for a donation of £100 to the Fund for the Promotion of Experimental Research at Low Temperatures.

A Combination of Acetic Acid with Nitric Acid.—Ainé Pictet and P. Genequand.—When we add nitric acid of 1·4 density to about an equal volume of acetic anhydride, a lively reaction is produced accompanied with a sufficient evolution of heat to cause the liquid to boil. If this mixture is submitted to fractional distillation, we obtain a principal fraction which passes over at 127·7° under 730 m.m. pressure. The analysis of this fraction gives the formula $C_4H_9NO_7$ or $2C_2H_4O_2+HNO_3$. The question arose, is this substance a simple mixture or a definite compound? The determination of the molecular weight showed that $C_4H_9NO_7$ is the true formula, and that therefore we have to do with a compound. The constitution of this body is probably expressed by the following formula: $CH_3-CO-O>N<OH$ (with CH_3-CO-O and OH), and we should look upon it as a mixed anhydride of acetic acid and orthonitric acid, $N(OH)_5$; *diacetylorthonitric acid* is a colourless liquid, fuming in the air, boiling at 127·7° under 730 m.m., and at 45° under 17 m.m. Its density is 1·189 at 23°, and its refractive index $n_D=1·38432$ at the same temperature. Cryoscopic examination shows that diacetylnitric acid, when mixed with water, undergoes complete dissociation, and this instability makes it very improbable that salts are formed; in fact, up to the present we have obtained absolutely negative results. This acid is also dissociated by heat, and although it will distil without change, a very slight increase of temperature above its boiling-point is sufficient to decompose it. A similar product was obtained by treating propionic acid in the same manner, but the other acids in the series, such as formic, butyric, and isovalerianic acids, gave only negative results.—*Bull. Soc. Chim.*, Series 3, vol. xxvii., No. 16—17.

The Oxidation of Aniline.—E. Bornstein.—Aniline, in the form of a salt in dilute, neutral, aqueous solution, is oxidised in the cold by PbO_2 or MnO_2; there is an intermediate formation of an aminoquinone, which condenses with the excess of aniline, giving aminodiphenylquinonediimide, $NH_2C_6H_3(NC_6H_5)_2$; by operating in more concentrated solution azophenine is formed; the author gives 246° as the fusing-point of this latter body. Aminodiphenylquinonediimide crystallises from an acetone-alcoholic solution in thin prisms of a bluish-red colour, collected together in stars, fusible at 167°; it is soluble in benzene, acetic ether, CS_2, $CHCl_3$, acetone, and ether, and slightly soluble in alcohol; this compound dissolves in sulphuric acid, giving a red solution, which becomes bluish-violet on heating; when cooled and diluted with water we obtain a blue solution with red fluorescence (reaction of fluoridine). The reduction of aminodiphenylquinonediimide by sulphide of ammonium gives a compound fusible at 83°, giving an acetylised derivative fusible at 170—171°. By the action of aniline and its hydrochlorate with the addition of $ZnCl_2$, aminodiphenylquinonediimide is transformed into azophenine.—*Berichte*, vol. xxxiv., p. 1268.

Action of Chlorides and Anhydrides of the Acids of the Fatty Series on Polymerised Methanal.—Marcel Descudé.—If to one molecule of polyoxymethylene we add one molecule of chloride of acetyl, then a pinch of melted powdered chloride of zinc, an extremely violent reaction is soon manifested, while the polyoxymethylene disappears in a few instants. A colourless, limpid liquid is obtained which does not contain a trace of chloride of acetyl; it consists principally of chloroacetate of methylene, but it contains also bichlorised methylic ether and diacetate of methylene. If we heat a mixture, molecule for molecule, of pure acetic anhydride and polyoxymethylene to about 130°, in the presence of chloride of zinc, we observe that in a few moments the polyoxymethylene has completely disappeared as well as the chloride of zinc. After distilling *in vacuo* we recover a quantity of liquid equal to the weight of the mixture within 2 or 3 per cent. It is formed principally of diacetate of methylene, and is identical with the product resulting from the action of iodide of methylene on acetate of potassium; it is fairly soluble in water, which only decomposes it slowly; it boils at 170°, and its density at 20° is 1·136°. But this is not the only body formed during the reaction. After the distillation is complete on the water-bath an important residue remains; if we now continue the operation on an oil-bath at about 130° the thermometer rises rapidly, and remains steady at 102° at 14 m.m. pressure, although the oil-bath may be heated to more than 180° at the end. By this means we obtain a colourless liquid which, when re-distilled at the ordinary pressure, passes over almost entirely between 204° and 207°. Analysis and cryoscopy give it the formula $C_6H_{10}O_5$; its constitution is probably as follows:—

$$CH_3-COO-CH_2-O-CH_2-COO-CH_3$$

this new body is called diacetate of oxide of methylene.—*Bull. Soc. Chim.*, Series 3. vol. xxvii., No. 16—17.

Merck's Digest. No. 12. Lecithin.—Lecithin is an important constituent of animal and vegetable tissues occurring more especially in the nerves, the brain, the yolk of eggs, also in blood, and in the chlorophyl of plants. Generally, it is associated with the cell nucleus, and especially in young cells lecithin exists in the form of an albumenoid compound. Lecithin can be prepared from the germs of the oat or from yolk of egg, but at present is prepared for medicinal purposes almost exclusively from the latter material, under the name of ovolecithin. Chemically, lecithin is to be regarded as a distearic-glycerophosphoric cholin ether, its composition being represented by the formula—

$$C_3H_5\begin{cases}O.CO.C_{17}H_{35}\\O.CO\,C_{17}H_{35}\\O.PO(OH)OC_2H_4N(CH_3)_3OH.\end{cases}$$

Ovolecithin is a yellowish waxy mass, soluble in hot alcohol, also in chloroform, benzene, or fat oils. In water or physiological salt solution it swells up, forming a jelly. It is recommended in cases of diseases arising from disturbances of nutrition, and for diseases of the brain and nervous system. The remarkably rapid increase of red blood corpuscles, observed as a result of the administration of lecithin, indicates that it is a valuable means of effecting blood formation. M. Serono observed in cases of chlorosis and anæmia that the increase of red corpuscles was as much as from 800,000 to 1,500,000 per c.c.; its powerful tonic action is also exercised in the most beneficial manner.

Transformation of Tartaric Acid into Oxalacetic Acid by the Elimination of Water at a Low Temperature.—A. Wohl and C. Œsterlin.—The authors have succeeded in transforming tartaric into oxalic acid in the following manner:—Diacetyltartaric acid is first prepared by Thiele's method of acetylation (acetic anhydride and sulphuric acid); it is then treated with pyridine cooled down to $-5°$; a pyridic compound is formed which the authors regard as the pyridine salt of oxymalic anhydride, which, under the action of dilute sulphuric acid, gives oxalacetic acid. This oxalacetic acid fuses at 146°, that prepared by Fenton, by applying his method of oxidation to malic acid (H_2O_2 and a salt of iron), fuses at 176°; the two bodies are transformed easily one into the other. If we treat the pyridic compound in question with aniline at the ordinary temperature, there is a violent disengagement of carbonic acid, and pyruvic anilide is collected; this has been identified with that obtained by Nef, by means of its fusion-point, its hydrazone, and by the polymer which results from the action of ammonia.—*Berichte*, vol. xxxiv., p. 1139.

MEETINGS FOR THE WEEK.

MONDAY, 9th.—Society of Arts, 8. (Cantor Lectures). "Hertzian Wave Telegraphy in Theory and Practice," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S.

TUESDAY, 10th.—Royal Institution, 5. "Recent Advances in Photographic Science," by Sir William Abney, K.C.B., D.C.L., F.R.S.

WEDNESDAY, 11th.—Society of Arts, 8. "Existing Laws, By-Laws, and Regulations Relating to Protection from Fire, with Criticisms and Suggestions" (Fothergill Prize Essay), by T. Bryce Phillips.

THURSDAY, 12th.—Royal Institution, 5. "Insect Contrivances," by Prof. L. C. Miall, F.R.S.

—— Society of Arts, 4.30. "The Currency Policy of India," by J. Barr Robertson.

FRIDAY, 13th.—Royal Institution, 9. "Character Reading from External Signs," by Prof. Karl Pearson, F.R.S.

—— Physical, 5. "On the Interpretation of Milne Seismograms," by Dr. Farr. "A Potentiometer for Thermo-couple Measurements" and "A Resistance Comparator," by Dr. R. A. Lehfeldt. "A Direct-reading Potentiometer for Thermo-electric Work," by Dr J. A. Harker. "On the Measurement of Small Resistances," by A. Campbell.

SATURDAY, 14th.—Royal Institution, 3. "Light—its Origin and Nature," by Lord Rayleigh, F.R.S., &c.

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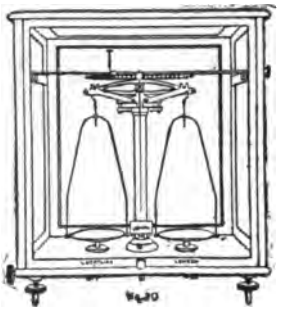

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THE CHEMICAL NEWS.

Vol. LXXXVII., No. 2259.

NOTE ON THE VOLUMETRIC ESTIMATION OF ZINC.

By J. E. CLENNELL.

A simple and accurate method for the estimation of zinc is much needed. Two principles are in general use, viz.,—

(*a*) The sulphide method.
(*b*) The ferrocyanide method.

Both require an external indicator. In the case of the sulphide method, lead salts, ferric hydrate, and sodium nitroprusside are commonly employed, but the exact finishing point is very difficult to determine. The end-point of the ferrocyanide method with uranium acetate is somewhat sharper, but cannot be regarded as altogether satisfactory.

In the method here described, the zinc is precipitated by means of a solution of sodium sulphide of known strength, added in slight excess, the excess of sulphide being then determined by making use of the reaction—

$$Na_2S + 2KAgCy_2 = Ag_2S + 2NaCy + 2KCy.$$

The solutions required are—

Sodium Sulphide.—A convenient strength being about 0·2 per cent Na_2S.

Silver Double Cyanide.—Prepared by adding silver nitrate to a solution of potassium cyanide (say, 2 or 3 per cent KCy) till a slight permanent precipitate of AgCy is produced, allowing to stand, and filtering.

Silver Nitrate.—Any dilute solution of known strength. A convenient standard is one containing 5·215 grms. $AgNO_3$ per litre, 1 c.c. being equivalent to 0·001 grm. zinc.

Potassium Iodide.—1 per cent solution.

It is perhaps advisable also to have a standard zinc solution prepared from pure metallic zinc or re-crystallised zinc sulphate, and containing (say) 0·5 per cent to 1 per cent Zn.

Method.

The zinc in ores or similar substances is brought into solution in the ordinary way, and the liquid made strongly alkaline with caustic soda or ammonia, boiled, diluted, and filtered if necessary. In cyanide solutions, the sulphide may in general be applied direct; in some cases, however, it may be necessary to remove the cyanogen by a preliminary operation.

The liquid to be tested is mixed with a measured volume of sodium sulphide, slightly in excess of that required to precipitate the whole of the zinc. The liquid is well shaken in a stoppered flask; a little lime may be added to promote settlement. The whole, or an aliquot part, is then filtered, and an excess of the double silver cyanide added. The precipitate of Ag_2S generally settles rapidly, and is easily filtered and washed (occasionally it may be necessary to add a little more lime). About 5 c.c. of the 1 per cent KI solution are added to the filtrate, and the liquid titrated with $AgNO_3$ till a slight yellowish turbidity remains permanent.

1 grm. KCy = 0·3 grm. Na_2S = 0·25 grm. Zn.

Results.

The accompanying table illustrates the results of titrations made by this method with solutions containing known quantities of zinc.

In the tests (5, 6, 7) made with zinc double cyanide, a separate portion of the original liquid was tested in the ordinary way for "total cyanide," *i.e.*, by titration with silver nitrate, using alkaline iodide indicator, and the cyanide so found deducted from the amount shown by titration after adding sodium sulphide and the double silver salt. In test No. 4, however, the cyanide was precipitated before making the estimation of zinc, by adding excess of $AgNO_3$, and then a few drops of HCl to remove excess of $AgNO_3$, boiling, and filtering; making strongly alkaline with NaOH before adding Na_2S.

In presence of ferrocyanide and thiocyanate, it appears to be necessary to make the solution strongly alkaline to ensure complete precipitation of the zinc sulphide.

Estimation of Alkaline Sulphides.

It is obvious that the same principle may be applied for the estimation of alkaline sulphides. The results with solutions containing varying amounts of sulphide are very closely proportional to the amount of sulphide used. When the liquid to be tested also contains cyanides, a separate portion of the original liquid must be titrated with $AgNO_3$ and iodide indicator after treatment with lead salts to remove sulphide, and the necessary correction applied.

No. of test.	Weight of $ZnSO_4.7H_2O$ taken.	Weight of K_2ZnCy_4 taken.	Weight of $K_4FeCy_6.3H_2O$ added.	Weight of KCNS added.	Weight of Na_2S added.	Weight of Zn found.	Weight of Zn present (by theory).
	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.
1.	0·2215	—	—	—	0·0855	0·0495	0·0500
2.	0·4430	—	—	—	0·1334	0·1004	0·1000
3.	0·4450	—	—	—	0·1710	0·1017	0·1004
4.	—	0·10	—	—	0·0427	0·0264	0·0263
5.	—	0·10	—	—	0·0654	0·0258	0·0263
6.	—	0·10	0·05	—	0·0654	0·0265	0·0263
7.	—	0·10	—	0·05	0·0654	0·0274	0·0263

A Synthesis of Naphthoïc Acid and of Naphthalene.—E. Erlenmeyer and J. Kunlin.—This synthesis is based on the decomposition of cinnamylidene-hippuric acid, obtained by condensing cinnamic aldehyde with hippuric acid. By heating this acid with hydrochloric acid in sealed tubes at 110°—120° for eighteen hours, we observe a very strong odour of naphthalene on opening the tubes. In fact, the authors have isolated naphthalene from the product of the reaction; it fuses at 79°—80°, and, further, they obtained a mixture consisting of cinnamylidene-hippuric acid unchanged, benzoïc acid, and α-naphthoïc acid. Their intention was to transform first the cinnamylidene-hippuric acid into α-ketonic acid by reacting with alkalis on the said acid, but this process was accompanied by secondary reactions, which did not allow them to isolate the ketonic acid; by the action of hydrochloric acid, the α-ketonic acid, which ought to have been formed, is immediately transformed into α-naphthoïc acid and naphthalene, as has just been shown. The authors propose to examine some analogous reactions with the object of obtaining other derivatives of naphthalene.—*Berichte*, vol. xxxv., p. 384.

ON THE COMPLEX SALTS OF PLATINUM. PLATO-OXALONITRITES AND PLATO-OXALONITROUS ACID.

By M. VÈZES.

PLATO OXALONITRITE of barium, $Pt(C_2O_4)(NO_2)_2Ba,5H_2O$, of which the preparation and the principal properties have been described in a previous paper (*Bull. Soc. Chim.*, 1901, Series 3, vol. xxv., p. 157), will serve for the preparation of other salts, derived, as it is, from a plato-oxalonitrous acid having the formula $Pt(C_2O_4)(NO_2)_2H_2$.

I. *The Sodium Salt.*—Twelve grms. of plato-oxalonitrite of barium are dissolved rapidly in about 200 c.c. of boiling water, and treated with 20 c.c. of a solution of sulphate of soda containing 1 molecule of this salt per litre. An abundant white precipitate is formed, which collects easily at the bottom of the vessel. After cooling and filtering, the filtrate is evaporated rapidly. On the other hand, the precipitated sulphate of barium is washed, collected, and weighed; its weight is found to be 4·69 grms., and the theoretical weight calculated from the amount of material used is 4·67 grms.

When the filtrate is reduced by evaporation to about 10 c.c., it is allowed to cool, and the plato-oxalonitrite of sodium is deposited in the form of tabular crystals of a deep yellow colour, and corresponding to the formula $Pt(C_2O_4)(NO_2)_2Na_2+H_2O$.

The first deposit weighs 6 grms., the theoretical amount of the salt that should be obtained being 8·8 grms. The slow evaporation of the mother-liquor enables us to obtain the remaining 2·8 grms.

The salt thus obtained, of which M. Dufet has kindly made the crystallographic examination, occurs in the form of triclinic crystals, having facets $p(001)$, $o\frac{1}{3}(301)$, $a^1(10\bar{1})$, $i^1(011)$, and $e\frac{1}{3}(03\bar{1})$. Some of them are more simple, and have only the facets p, i^1, and a^1, this latter being striated parallel to the edge $p\,a^1$.

They have a perfect cleavage along $o\bar{3}$.

Triclinic System.

$a : b : c = 0{\cdot}68153 : 1 : 0{\cdot}94068.$

Plane Angles.		*Dihedric Angles.*	
$\alpha\ (b\,c)$ ..	89° 48′ 40″	A $(p\,g^1)$ ..	89° 53′ 45″
$\beta\ (a\,c)$ ..	90° 41′ 45″	B $(p\,h^1)$ ..	90° 40′ 40″
$\gamma\ (a\,b)$ ..	97° 6′ 20″	C (h^1g^1)..	97° 6′ 15″

Perpendicular Angles.

	Calculated.	Measured.
$p\,o\bar{1}$ (001) (301)	Base	*75° 53′
$a^1o\bar{1}$ (10$\bar{1}$) (301)	Base	*49° 23′
$p\,a^1$ (00$\bar{1}$) (10$\bar{1}$)	54° 44′	54° 45′
$p\,i^1$ (001) (011)	Base	*43° 31′
$i^1e\bar{1}$ (011) (03$\bar{1}$)	Base	*65° 57′
$p\,e\bar{1}$ (00$\bar{1}$) (03$\bar{1}$)	70° 32′	70° 31′
$a^1\,i^1$ ($\bar{1}$01) (011)	69° 34′	69° 33′
$i^1\,o\bar{1}$ (011) (301) ..	74° 58′	74° 53′
$a^1e\bar{1}$ (10$\bar{1}$) (03$\bar{1}$)	Base	*73° 17′
$o\bar{1}\,e\bar{1}$ (301) (03$\bar{1}$)	91° 49′	91° 48′

When dried in the cold on filter-paper, these crystals do not change in the air.

When submitted to the progressive action of heat they lose 1 molecule of water of crystallisation; but this dehydration, which is slow at about 100°, only becomes rapid when the temperature reaches 150° or 200°.

The greyish-yellow powder obtained in this manner, when heated more strongly, decomposes very rapidly at about 270°, like plato-oxalonitrite of potassium, according to the equation $Pt(C_2O_4)(NO_2)_2Na_2 = Pt + 2NO_2Na + 2CO_2$.

Plato-oxalonitrite of sodium is very soluble in water; in fact, it dissolves in about four times its own weight of cold water and in its own weight of boiling water. Its solutions are very stable.

The analysis of this salt, made by the methods I have already described for the potassium salt, gave the following results:—0·9472 grm. of material, heated to 200°, lost 0·0401 grm. of water; the dry product, decomposed by heat at 270°, left a residue weighing 0·7241 grm. This residue, calcined with an excess of sulphuric acid, gave a mixture weighing 0·7283 grm., and composed of 0·4224 grm. of platinum, and 0·3059 grm. of sulphate of sodium, containing 0·0992 grm. of sodium.

	Calculated.		Found.
		Per cent.	Per cent.
Pt	194·8	44·37	44·59
2Na	46·1	10·50	10·47
2C	24·0	5·47	—
2N	28·1	6·35	—
8O	128·0	29·21	—
H_2O	18·0	4·10	4·23
$Pt(C_2O_4)(NO_2)_2Na_2+H_2O$	439·0	100·00	—
$Pt+2NO_2Na$	333·0	75·85	76·45
$Pt+SO_4Na_2$	337·0	76·77	76·89

II. *The Ammonium Salt.*—A reaction similar to that which gave the preceding salt also enables us to obtain a solution of the corresponding salt of ammonium; by operating, as has been described above, with 12 grms. of plato-oxalonitrite of barium and 20 c.c. of a solution of sulphate of ammonium containing 1 molecule of the salt per litre, we obtain a deposit of sulphate of barium corresponding almost exactly to the whole of the barium and the sulphuric acid contained in the mixture (calculated, 4·67 grms. of sulphate of barium; found, 4·63 grms.). The yellow liquor, freed from the precipitate by filtration, should thus give by evaporation plato-oxalonitrite of ammonium; but whether we concentrate by heat or whether we leave it to spontaneous evaporation in a dry atmosphere in the cold, we observe that its concentration is accompanied by a disengagement of gas, which is a certain sign of decomposition. When carried out to the end, evaporation gives as a residue non-crystallisable products, of which it did not appear to be useful to continue the examination.

Plato-oxalonitrite of ammonium, of which we may remark the probable formula contains the elements of nitrite of ammonium, thus appears to be too unstable to be isolated in the crystalline form.

III. *Plato-oxalonitrous Acid.*—The same method appears to lead us to the acid from which the preceding salts are derived; we treated 7·57 grms. of plato oxalonitrite of barium, dissolved in 150 c.c. of warm water, with the equivalent amount of dilute sulphuric acid (50 c.c. of a titrated solution containing 0·2514 molecule of acid per litre).

The mixture of the warm solutions immediately gave a precipitate of sulphate of barium corresponding to the whole of the sulphuric acid and the barium contained in the solutions mixed (calculated, 2·93 grms. of sulphate of barium; found, 2·96 grms.). The filtrate obtained was limpid and of a bright yellow colour, and did not give a white precipitate with either sulphuric acid or chloride of barium; thus, it is free from barium and from sulphuric acid; but the latter of these reagents gave slowly and in the cold a deposit of yellow crystals of plato-oxalonitrite of barium. In the same way it gives a deposit of yellow crystals of plato-oxalonitrite of potassium, with a solution of a potassium salt. There is no doubt, therefore, that this yellow liquid is a solution of the plato-oxalonitrous acid, $Pt(C_2O_4)(NO_2)_2H_2$, corresponding to these salts.

But this acid is very unstable in concentrated solutions, for, if we evaporate this solution, either by the action of

heat or of a vacuum, or even slowly in the cold in dry air, it becomes red, and gives off nitrous fumes which are the evident signs of decomposition. Eventually it becomes syrupy, and takes a deep blue colour, without giving any crystalline deposit. Thus, plato-oxalonitrous acid appears to be too unstable to be obtained in any other state than that of a solution.

IV. *The Case of the Salts of Heavy Metals.*—Finally, we have endeavoured to prepare, by the same method, plato-oxalonitrites of the heavy metals; as an example, we will give the case of copper. Twelve grms. of plato-oxalonitrite of barium were dissolved in warm water and treated with 20 c.c. of a solution of sulphate of copper at 1 molecule per litre. The abundant precipitate formed by the mixture of these solutions had a bluish tint; its analysis showed that it contained, besides the whole theoretical amount of sulphate of barium which ought to be formed by the reaction (calculated, 4·67 grms.; found, 4·66 grms.), a quantity of oxalate of copper containing nearly the whole of the copper and the oxalic acid present in the mixed solutions (it gave 1·4 grms. of oxide of copper instead of 1·6 grms.). The filtrate, on evaporation, gave, besides a deposit of oxalate of copper containing the remainder of the oxalic acid and the copper used, products similar to those formed by the decomposition of plato-nitrous acid, notably a red substance, probably identical with the triplato-octonitrous acid of M. Nilson (*Berichte*, 1877, vol. x., p. 934).

Thus it appears to result from this experiment that the plato-oxalonitrites of the heavy metals are still less stable, in the presence of water, than the acid from which they are derived, and cannot be obtained in the stable condition in solution. We may add that we have already been brought to the same conclusion by another means (*Bull. Soc. Chim.*, vol. xxvii., p. 932), when examining the action of the salts of the heavy metals on solutions of plato-oxalonitrite of potassium.—*Bull. Soc. Chim.*, Series 3, vol. xxix. No. 2.

THE ESTIMATION OF DIGITALIN IN PHARMACOPŒIAL PREPARATIONS OF DIGITALIS AND DIGITALIN.*

By M. ECALLE.

Throughout this paper the term "digitalin" will apply exclusively to the crystallised digitalin of the French Codex, obtained for the first time by M. Nativelle. This digitalin is completely soluble in chloroform and identical with the German *digitoxin* of Schmiedeberg.

The product called digitalin by this latter chemist is a glucoside of digitalis of which the physiological action is very different to that of the French digitalin.

Therefore it is necessary to establish very distinctly the difference between the two products so unfortunately designated by the same name, the more especially since Kiliani (*Journ. de Pharm. et de Chim.*, 1899, Series 6, vol. ix., p. 57) has been able to produce German digitalin in the crystalline form.

Crystallised French digitalin has the following characteristics:—It is insoluble in water, easily soluble in alcohol and in chloroform, less soluble in ether, and insoluble in petroleum ether. German digitalin is insoluble in water, and soluble in alcohol, but insoluble in chloroform.

French crystallised digitalin and German digitalin, further, have particular reactions which enable one to be distinguished from the other, when they are dissolved in concentrated sulphuric acid and an oxidising solution is added, such as bromine, nitric acid, or perchloride of iron.

Kiliani was the first to devise a practical method of operating, and it is this method slightly modified by Keller, and then again by Kiliani, that we have followed.

The two following solutions are prepared as reagents:—

Solution No. 1.

Pure sulphuric acid	100 c.c.
Solution of iron-alum at 5 per cent ..	1 ,,

Solution No. 2.

Glacial acetic acid	100 c.c.
Solution of iron-alum at 5 per cent ..	1 ,,

Method of Operating.—About 4 or 5 c.c. of solution No. 1 are poured into a test-tube. At the same time we dissolve in another test-tube, or better still in a test-glass, a trace of digitalin in about half a c.c. of solution No. 2; one drop of perchloride of iron is added to this latter, and this is then allowed to run slowly down the side of the tube containing solution No. 1, and remain a few minutes in contact.

With French digitalin, at the point of contact between the two layers of liquid, a dark coloured zone is formed, and above this, and consequently in the acetic acid, an absolutely characteristic blue-green ring.

With German digitalin, this blue-green colouration in the upper portion is not produced, but the lower portion (ferric sulphuric acid) becomes reddish-violet in colour.

The simultaneous appearance of both these reactions enables us to detect a mixture of both the digitalins (Kiliani, *Journ. de Pharm. et de Chim.*, 1896, Series 6, vol. iv., p. 29).

According to Keller (*Journ. de Pharm et de Chim.*, 1897, vol. vi., p. 167), crystallised French digitalin being much the most active of all the glucosides found in, and isolated from, digitalis, we may conclude that the value of a digitalis, or of its preparations, should be proportional to the amount of crystallised digitalin it contains. To effect this, estimation would be therefore a means of fixing its value.

It is this that we have endeavoured to do. The method we adopted was that of Keller (*loc. cit.*, p. 168). After several trials, however, we found it advisable to make some modifications, which give, in our opinion, much greater accuracy to the results.

The process we have finally decided on was tested on a solution of digitalin mixed with an inactive dissolved extract (extract of "dog's tooth").

0·236 grm. of crystallised digitalin was dissolved in 5 c.c. of alcohol at 90°, and then mixed with a solution of 2 grms. of extract of dog's tooth in a sufficient quantity of distilled water, the total volume being made up to about 150 c.c. This solution is treated with 25 c.c. of 1 in 10 neutral acetate of lead, and the volume then made up to exactly 200 c.c.

After well stirring and filtering, 100 c.c. of the filtrate were taken. These 100 c.c. were treated with 10 c.c. of a solution of sulphate of soda at 50 per cent to remove the excess of lead. After standing for forty-eight hours, 90 c.c. of the clear liquid were removed by decantation.

It is on these 90 c.c., which represent $\frac{9}{20}$ths of the total volume of liquid, that the actual estimation of the digitalin is to be made. However, this volume of 90 c.c. is not fixed arbitrarily; we simply decanted as much of the clear liquid as possible, and used this solution after having measured its volume exactly.

To the decanted liquid we added 2 c.c. of 10 per cent ammonia and 30 c.c. of chloroform. The whole is then poured into a bulb vessel of about 250 c.c., fitted with a tap, and shaken moderately (about 20 or 30 shakes), then left to settle. The decanted chloroformic solution is filtered, preferably through a filter-paper moistened with chloroform.

The operation is repeated five times with an equal volume of chloroform. Sometimes it is necessary, in order to exhaust the liquors completely, to shake more vigorously in some of these operations. An emulsion may commence to be formed, in which case the whole must be

* A Paper read before the Société de Pharmacie, Feb. 4th, 1903.

left to stand for forty-eight hours. All the chloroformic liquors, united in one beaker, are evaporated on a water-bath, and dried by means of a current of hot air.

When the evaporation is completely finished, the residue is re-dissolved in about 3 c.c. of chloroform, and the chloroformic solution placed in another Bohemian glass beaker previously tared, and of about 100 c.c. capacity.

To this solution we add 10 c.c. of sulphuric ether of 0·720 density, and 70 c.c. of petroleum ether.

The mixture is shaken carefully, and left to settle for forty-eight hours, after taking care to cover the beaker with a clock glass, so as to prevent a too great evaporation of the solution.

The clear liquid is then decanted as far as possible, and the remainder evaporated, first on a water-bath, and then when very little liquid is left, about 1 c.c., it is dried by means of a current of hot air.

The beaker is then placed in a desiccator, and weighed after cooling.

The amount of digitalin obtained was 0·0098 grm., or, for the total quantity of solution, $\frac{0{\cdot}0098 \times 110}{90} \times 2 = 0{\cdot}0239$ grm. instead of the 0·0236 grm. originally taken.

By this method we have estimated the digitalin in several preparations of digitalis.

Results.

The following are some of the results we have obtained:—

1. *In a Commercial Tincture of Digitalis made according to the Formula in the Codex.*—The estimation was made on 100 grms. of the tincture, which were evaporated on the water-bath down to 10 c.c. These 10 c.c. were taken up with 100 c.c. of distilled water, and the estimation proceeded with as above.

We found 0·0398 grm. of digitalin in the 100 c.c. of tincture of digitalis; that is, 0·398 per 1000.

Under these conditions digitalin occurs, as Keller observed, in the form of a partially crystallised varnish. It is not absolutely pure when operating with a tincture, an extract, or with leaves, but contains slight traces of German digitalin. The estimation completed, a trace of the 39·8 m.grms. of digitalin obtained gave the characteristic reaction of identity.

The same verification was done for each of the estimations made in the course of this research.

2. *In an Etherial Tincture of Commercial Digitalis made according to the Formula in the Codex.*—100 grms. of the etherial tincture of digitalis were evaporated with the necessary precautions, the residue taken up with distilled water, and the evaporation continued as above. Result:—0·02337 grm. per 100 grms. of the tincture; that is, 0·2337 grm. per 1000.—*Journ. de Pharm. et de Chim.*, Series 7, vol. xvii., No. 5.

Some Metallic Fluorides in the Dissolved State.—A. Jœger.—Mercuric fluoride in solution is to a great extent hydrolysed (80 per cent), and the examination of the hydrolysis points to the formula H_2F_2 for hydrofluoric acid. With cupric fluoride the hydrolysis is much less considerable. The solubility of fluoride of cadmium in water is 0·3 molecule, its solubility in hydrofluoric acid is much greater; apparently there is a formation of a hydrofluorate of the fluoride. Fluoride of lead is distinguished from the other halogen salts of lead by its extremely slight solubility in water, 5·5 milli-molecules per litre. The hydrate, $Pb(OH)_2$, decomposes the alkaline halogen salts until a certain equilibrium is established owing to the formation of free alkali. The same phenomenon can be observed by substituting the halogen salts of lead for the alkaline salts; under these conditions, either a basic or a complex salt is formed.—*Zeit. Anorg. Chemie*, vol. xvii., p. 22.

ON THE ACTION OF CARBONIC OXIDE ON THE MANGANO-, COBALTI-, CHROMO-, AND PLATINO-CYANIDES OF POTASSIUM.

By J. A. MULLER.

THE decided action of carbonic oxide on ferro- and ferricyanide of potassium, with the formation of carbonylferrocyanide, induced me to try if the other complex cyanides were susceptible of reacting on this gas with the formation of the corresponding carbonylcyanides.

With this object I have made two series of experiments; in the first series, I heated an aqueous solution of the cyanide under examination in an atmosphere of carbonic oxide in sealed tubes for fifty hours at about 130°; in the second series, I heated the same solutions for thirty-six days at about 70°.

We will examine first the results obtained with manganocyanide of potassium, and then those given by the three other cyanides.

Manganocyanide of Potassium.—This crystallised salt was used in the form of good though small crystals of a violet-blue colour, and was obtained by re-crystallising in a solution of cyanide of potassium, the blue crystalline precipitate prepared by reacting with small pieces of cyanide of potassium on a solution of manganous acetate.

In a preliminary experiment 1·25 grms. of the manganocyanide, dissolved in 10 c.c. of a solution of cyanide of potassium, was heated to 130°, in the presence of 0·110 grm. of carbonic oxide. After heating, an absorption of 0 035 grm. of this gas was observed; the liquid in the tube had a very pale yellow colour; it was ammoniacal, but still contained cyanide of potassium. As this liquid was easily oxidisable in the air, it was collected in a flask full of nitrogen. With an excess of sulphate of zinc it gave a pure white gelatinous precipitate, whereas a solution of manganocyanide in dissolved cyanide of potassium gives a violet-blue precipitate with this sulphate.

In a second experiment, 1·157 grms. of manganocyanide treated with 5 c.c. of water (which gave rise to the formation of a green precipitate of mangano-potassic manganocyanide, $MnK_2Mn(CN)_6$), was heated to 130° in the presence of 0·090 grm. of carbonic oxide, of which 0·011 grm. was absorbed. The characteristics of the solution contained in the tube after heating, were practically the same as those in the first experiment. The same is the case with the solutions obtained in the experiments made at 70°:—

	Manganocyanide dissolved in 5 c.c. of concentrated solution of KCN.	Manganocyanide treated with 5 c.c. of water.
	Grm.	Grm.
Weight of manganocyanide of potassium used	1·208	1·157
Weight of CO used	0·099	0·099
Weight of CO absorbed ..	0·025	0·009

The total transformation of the manganocyanide into carbonyl-manganocyanide analogous to the carbonylferrocyanide, would require, for 1·25 grms. of dry manganocyanide, an absorption of 0·095 grm. of carbonic oxide. Now, in all the experiments made, the amount of carbonic oxide absorbed has been always very far from this weight. This absorption of carbonic oxide, however, was never negligible, but it may be attributed—for the most part at any rate—to the alkalinity of the solution in which the reaction took place, an alkalinity which was considerable, especially in solutions containing an excess of free cyanide of potassium. As for the absence of manganocyanide in the different liquids from the tubes, after heating, it must be caused by an almost complete hydrolysis of the molecule of manganocyanide, a molecule which is, as is known, much less stable than that of ferrocyanide of potassium.

Cobalti-, Chromo-, and Platinocyanides of Potassium.—The first of these salts was obtained by dissolving

	$K_3Co(CN)_6$, 2·5 per cent solution.	$K_3Cr(CN)_6$, 3 per cent solution.	$K_2Pt(CN)_4$, 3·5 per cent solution.
$FeCl_2$	White precipitate, slightly yellowish.	Brick-red precipitate.	Voluminous white precipitate.
$FeCl_3$	Nothing at first; then pale yellow cloudy precipitate.	Nothing at first; then brown precipitate.	Nothing first; then yellowish white precipitate.
$Co(NO_3)_2$	Rose precipitate.	Flocculent rose precipitate.	Pale lilac precipitate.
$NiCl_2$	Pale green gelatinous precipitate.	Blue-green gelatinous precipitate.	Very pale green precipitate.
$MnSO_4$	White precipitate.	Yellowish white crystalline precipitate.	Nothing.
$ZnSO_4$	Milky white precipitate.	Yellowish white crystalline precipitate.	White crystalline precipitate.
$Cu(C_2H_4O_2)_2$ ..	Turquoise-blue precipitate.	Pale blue precipitate.	Pale greenish blue voluminous precipitate.
$AgNO_3$	Gelatinous white precipitate.	Pale yellow gelatinous precipitate.	Gelatinous white precipitate.
$Hg_2(NO_3)_2$ . ..	White precipitate.	White precipitate, turning grey.	Ultramarine precipitate.
$HgCl_2$	Nothing; then white precipitate.	Yellow colour.	Crystalline white precipitate.
$Pb(C_2H_4O_2)_2$ ..	Nothing.	Nothing.	Nothing.
$UO_2(NO_3)_2$ . ..	Nothing.	Nothing.	Nothing.

cobaltous cyanide in a solution of cyanide of potassium, filtering, oxidising in the air, saturating with carbonic oxide, filtering a second time, acidulating with acetic acid, precipitating with alcohol, re-dissolving the washed precipitate in water, and precipitating a second time with alcohol, and finally draining and drying at 105°.

I obtained chromocyanide of potassium in magnificent amber-yellow crystals by following Odin Christensen's method (*Journ. f. Prakt. Ch.*, 1885, vol. xxxi., p. 163).

As for the platinocyanide, I bought it at M. Poulenc's. Its analysis gave H_2O, 12·43 per cent of the crystalline salt (theory for $K_2Pt(CN)_4,3H_2O$, 12·53 per cent); in the dry salt I found Pt = 51·77 and K = 20·58 (theory requires 51·63 and 20·75).

When dissolved in water the platinocyanide does not undergo any modification on heating, either to 70° or to 130°, in an atmosphere of carbonic oxide. Under the same conditions, the solution of cobalticyanide deposits a slight rose-coloured precipitate, apparently formed of cobaltous cobalticyanide still containing potassium; the weight of this precipitate was 0·023 grm. in the experiment at 130°, and 0·008 grm. in that at 70°. Finally, chromocyanide in solution is almost entirely decomposed at 130°; an abundant green precipitate is formed, consisting principally of oxide of chromium, while the solution contains only a trace of chromocyanide; during the reaction formates are produced as well as ammonia, but no carbonates or oxalates. At a temperature of 70° the decomposition of the chromocyanide is much less (0·005 grm. Cr_2O_3 for 0·999 grm. of $K_3Cr(CN)_6$).

Below I give the quantities of the different compounds used in the experiments, and the weights—always very small—of the oxide of carbon absorbed in the experiments at 130° for fifty hours, and at 70° for thirty-six days:—

	$K_3Co(CN)_6$.		$K_3Cr(CN)_6$.		$K_2Pt(CN)_4,3H_2O$.	
	At 130°. Grm.	At 70°. Grm.	At 130°. Grm.	At 70°. Grm.	At 130°. Grm.	At 70°. Grm.
5 c.c. of aqueous solution containing.. ..	1·011	1·015	0·999	0·999	1·204	1·186
CO used	0·074	0·091	0·085	0·088	0·086	0·088
CO absorbed ..	0·002	0·002	—	0·002	0·004	0·003

After heating, either at 70° or at 130°, the solutions of cobalti- and platinocyanide are neutral, and—as a result of comparative trials made—have the same action with reagents as before heating, except that the tints of the coloured precipitates obtained with the solutions of cobalticyanide of potassium when heated are very slightly paler than those obtained with unheated solutions.*

As for the dissolved chromocyanide, it is completely decomposed—as has been said already—at 130°; after heating to 70°, the solution contained in the tube is yellow, with an odour slightly ammoniacal but distinctly hydrocyanic; further, it has the characteristics of chromocyanide of potassium, except that the precipitate formed by acetate of copper is greenish blue instead of being bright blue.

In the accompanying table I have summarised the characteristics of the three latter salts of which I have just spoken, characteristics which have enabled me to indentify them before and after heating in an atmosphere of carbonic oxide.

Remarks.—All the precipitates formed by cobalticyanide of potassium are insoluble in sulphuric acid at 15 per cent even when boiled.

The precipitate formed by the platinocyanide with $FeCl_2$ is soluble hot, and that obtained with $FeCl_3$ is soluble in the cold in sulphuric acid at 15 per cent. The other precipitates are insoluble; that formed with $Hg_2(NO_3)_2$ is decomposed by sulphuric acid.

With the exception of the precipitates formed with $AgNO_3$ and $Hg_2(NO_3)_2$, all the precipitates obtained with the chromocyanide are soluble on boiling in sulphuric acid at 15 per cent, with the evolution of hydrocyanic acid.

To sum up, the preceding experiments show that:—(1) The cobalti-, chromo-, and platinocyanides of potassium do not appear to be able to form carbonylcyanides analogous to the carbonyl ferrocyanide of potassium, and that the existence of a carbonyl manganocyanide of potassium is doubtful; (2) that the mangano- and chromocyanides of potassium are much less stable in the presence

* Before heating, these solutions are of a pale yellow colour; after heating, especially at 130°, they are almost colourless.

of water than the corresponding ferro- and ferricyanides. In the case of the chromocyanides obtained by double decomposition, it was specially noticed that the precipitates formed are soluble, for the most part, in dilute sulphuric acid, with the evolution of hydrocyanic acid, the same as the simple double cyanides.—*Bull. Soc. Chim.*, Series 3, vol. xxix., No. 1.

THE EFFICIENCY OF ELECTRIC FURNACES.*

By JOSEPH W. RICHARDS.

An electric furnace is a furnace for accomplishing a physical or chemical change in materials by means of the agency of heat, said heat being supplied by the transformation of electric energy. The change or effect on the materials treated being due to the heating, the output of the furnace or the capacity, as measured by amount of material treated and amount of product obtained, will be more or less proportional to the amount of heat energy developed in the furnace. I say "*more* or *less* proportional" because, although the amount of heat necessary to produce the change in a given amount of material may be a perfectly definite quantity, yet the proportion of the heat developed in the furnace which is actually absorbed or applied in producing this change is a variable one, being always less than 100 per cent, and frequently very much less. The proportion of the heat energy of the electric current thus applied to producing the useful physical, or physical and chemical, change in the charge, is what I term the *efficiency* of the furnace.

The usefully applied heat will include one or both of two factors. The first factor is, the amount of heat necessary to heat the charge up to the temperature of the furnace. This is a physical change, and is found by taking into consideration the items of the charge, their specific heats in the solid state, also their specific heats in the liquid state, and their latent heats of fusion, if they are melted, and the temperature to which they are heated. We thus obtain the quantity of heat necessary to bring them, and thence the whole charge, up to the working temperature of the furnace. My friends who are fond of mathematical expressions can easily put this proposition into the shape of a simple formula, but the matter will be easily understood as expressed above. In some electric furnace operations this is the only result aimed at, and the ratio of this amount of heat to that generated by the conversion of the electric current into heat energy, will be the useful effect or *efficiency* of the operation. The second factor, which appears in many, and in fact in the majority, of cases, is the heat absorbed in chemical reactions between the constituents of the charge when they are heated to the reacting point, which is the temperature of the furnace. This is a thermochemical question. The physical state which conditions a chemical reaction is usually *fluidity*, coupled with opportunity for gaseous products of the reaction to escape from the sphere of reaction as soon as they are formed. This is a condition analogous to the insolubility of a possible product in a solution, which factor usually conditions a chemical reaction in solution by removing from the sphere of reaction the least trace of the new product as soon as formed, and therefore causing its formation to continue if there is the slightest predisposing tendency to its production. The reactions thus brought about in the charge in electric furnace operations are usually heat-absorbing reactions, and the heat thus absorbed must be supplied by the furnace; that is, taken from the energy of the current. This amount must then be added to the heat required to bring the charge up to its reacting temperature, and the sum constitutes the usefully applied heat, and its ratio to the whole heat energy of the current is what I would term the *efficiency* of the furnace.

The degree of efficiency thus attainable depends on many factors, a partial enumeration of which is: Size of the furnace, temperature of the reaction, protection from radiation, management of the terminals, feeding and tapping, general management. Of these, by far the most important, in commercial practice, is the size of the furnace. Large bodies cool much more slowly than small ones, and this is because their radiating surface, by which they lose heat, is *proportionately* so much smaller. A suspended cube of any material, one metre on its edge, has one cubic metre volume to six square metres radiating surface; if one decimetre on its edge, it has one litre volume to six square decimetres radiating surface. That is, for one-thousandth the volume it has one-hundredth the radiating surface. Expressing it the other way, the larger cube has only one-tenth the radiating surface of the smaller one *per unit of volume or contents*. It follows that if the two cubes are heated to the same temperature, the larger one will lose only one-tenth as much heat in a given differential of time, per unit of contents, as the smaller one. If, therefore, it is wished to operate a furnace at a given fixed temperature, the loss by radiation is reduced very greatly by increasing the size of the furnace and the scale of the operation. The capacity or contents of the furnace increases approximately as the cube of the linear dimensions; the radiating surface, conditioning the loss of heat, increases as the square of the linear dimensions; therefore the proportion of radiating surface to unit of contents *decreases* approximately in proportion as the linear dimensions are increased. Make a circular furnace of twice the diameter and twice the height, its cubic capacity is increased eight times, and its radiating surface four times, and if eight times the current energy is used there will be approximately only half as much percentage loss by radiation in the larger furnace. This consideration alone would indicate the probability that if a 100 horse-power electric furnace was working at an efficiency of 50 per cent with the other 50 per cent lost by radiation and conduction, that an 800 horse-power furnace of the same design working the same process at the same temperature, should lose only 25 per cent and give an efficiency nearer to 75 per cent. Indeed, it is quite conceivable that at the limit, a change from working a furnace process from the smallest practicable scale to the largest practicable scale, might convert an operation working at 10 per cent efficiency and 90 per cent loss into an operation of 90 per cent efficiency and 10 per cent loss. Along with the increased size, where possible, comes also, in general, greater uniformity of working, regulation of temperature and control of the process, so that most of *desiderata* of commercial success lie in the direction of increasing the size of the furnaces to the furthest limit set by mechanical or physical considerations.

Dr. Borchers has classified electric furnaces into the resistance type and the arc type, the former being subdivided into those in which the material to be heated is heated by its own resistance, or by the resistance of a contiguous conductor, the latter being subdivided into those in which the charge is fed directly into the arc or is heated by radiation from the arc. For the purposes of our calculations of *efficiency*, however, we will classify the operations according to the nature of the change brought about in the charge, and therefore distinguish, first, operations in which the charge undergoes simply a physical change, and second those in which the change is both physical and chemical. The first class would include those in which the charge is simply heated without melting as well as those in which it is fused; the second would include those in which *chemical* change takes place without melting the charge, or with a fusion of the same. As types of these four classes we might mention, in their order, the graphitisation of carbon, the melting of alumina, the production of carborundum, the production of barium oxide.

* A Paper read at the Second Meeting of the American Electrochemical Society, Niagara Falls, N.Y., September 15th, 1902. From the *Transactions of the American Electrochemical Society*, ii., p. 51.

Siemens tried to introduce on a commercial scale the electrical fusion of steel by an electric arc. He has stated that the results he obtained on an experimental scale showed 50 per cent of the heat energy of the current to have been utilised. This was, however, on a small scale, using but 2 horse-power, and a greater efficiency would certainly have been attained working on a larger scale. This class of operations however, as we will see later, seem to give a higher efficiency than those in which chemical changes supervene.

Heating alone without Fusion.

As example of this we will take the conversion of anthracite coal into graphite, in the Acheson furnaces. It is true that some chemical changes probably occur during the conversion, such as the progressive formation and decomposition of carbides, but these are negligible because of their plus and minus heat quantities neutralising each other; the change from amorphous carbon to graphite is a heat-*evolving* reaction, and therefore must be reckoned as really *assisting* the current, or practically diminishing in our figuring the calculated efficiency.

The data are as follows: 1000 horse-power in twenty hours converts 12,000 pounds of anthracite into 10,000 pounds of graphite. Assumed temperature of the furnace 3300° C.; specific heat of coal to that temperature 0·5; heat of conversion 236·5 calories per pound of graphite formed.

N.B. [For convenience we will use *pound calories* (per 1° C.), as giving all figures needed for our calculations of efficiency without transposing the data.]

Heat equivalent of the current: 20,000 cal. per minute = 24,000,000 cal. per 20 hours.

Heat used in heating charge: 12,000 × 0·5 × 3300 = 19,800,000 cal. = 82·5 per cent.

Heat gained in conversion into graphite: 10,000 × 236·5 = 2,365,000 cal., or an amount equal numerically to 10 per cent of the heat supplied by the current.

Heat lost by radiation and conduction: 100 − 82·5 = 17·5 per cent of the heating power of the current.

Efficiency: The real amount of heat available was 100 + 10 = 110 per cent of the heating power of the current. Of this 82·5 per cent was utilised, giving an efficiency of 82·5 ÷ 110 = 75 per cent.

In the Acheson process of graphitising electrodes by placing them crosswise embedded in a resistant material, a considerably smaller proportion of the energy goes into the articles being graphitised because the resistance material has also to be heated to the temperature of graphitisation. In this case, the actual heat furnished to the carbons being graphitised is approximately half of the total heat absorbed by the charge, and only 38 per cent of the total heat available.

Data: 1000 horse-power graphitises 7000 pounds of electrodes embedded in 7000 pounds of granular carbon and lining.

Energy of current: 28,800,000 pound calories.

Heat in electrodes: 7000 × 0·5 × 3300 = 11,550,000 calories.

Heat of conversion: 7000 × 236·5 = 1,655,500 calories.

Total heat available: 30,455,000 calories.

Net efficiency of operation $\frac{11,550.000}{30,455,000}$ = 38 per cent. applied to useful purpose.

Heating alone with Fusion.

The Jacobs' process of fusing calcined bauxite is an illustration. The process is simple fusion by the arc in a cylindrical pot.

Energy of current: 215 horse-power for fourteen hours = 3,612,000 pound calories per run.

Heat in charge:—The heat in liquid alumina has not been determined experimentally. From a consideration of the heat in liquid slags and the temperature of the furnace, it is thought that 880 pound calories per pound of liquid alumina is a probable value. This would make the heat in 3000 pounds of charge 2,640,000 calories = 74 per cent of the total energy available.

Heating and Chemical Change, without Fusion.

The manufacture of carborundum is a good example. A mixture of carbon, silica sand, and salt is heated by the incandescence of a conducting carbon core, until the salt is volatilised, carrying off most of the metallic impurities as chlorides; the silica is reduced and combines with the excess of carbon present to form silicon carbide. The furnace is 20 feet long, and 1000 horse-power of current is passed through for thirty-six hours.

Charge.

1,000	pounds	carbon	in core.
7,200	,,	,,	,, charge.
12,000	,,	silica	,, ,,
3,000	,,	salt	,, ,,
7,000	,,	silicon carbide formed.	

Assumptions: temperature of furnace 3000° C.; specific heat of carbon 0·5, of silica 0·25, of salt 0·2. Heat of formation of silica = 200,000 calories (per 60 pounds), of carbonic oxide 29,000 calories (per 28 pounds), of silicon carbide small but positive, and assumed as 2000 calories (per 40 pounds). It is further assumed that only the part of the charge actually reduced is heated to the full temperature of the furnace, and the heat going into the unreduced material or packing is not included in the *efficiency*. Reaction assumed—

$$3C + SiO_2 = CSi + 2CO.$$

Heat energy of current: 1000 horse-power for thirty-six hours = 45,620,000 pound calories.

Heat absorbed in heating up part of charge reduced or volatilised: 7300 pounds of carbon = 7300 × 0·5 × 3000 = 10,950,000 calories; 10,500 pounds of silica = 10,500 × 0·25 × 3000 = 7,875,000 pounds calories; in salt volatilised 3000 × 50 = 150,000 calories. Total 18,975,000 calories = 42 per cent of energy of current.

Heat absorbed in chemical reactions: The heat required to split up one molecular weight (60 pounds) of silica is 200,000 calories; the formation of one molecular weight of silicon carbide and two molecular weights of carbonic oxide gives us 60,000 calories, leaving a deficit of 140,000 calories per molecular weight of carbide formed (40 pounds, or 3500 calories per pound of carbide, or 24,500,000 calories for the total 7000 pounds of carbide = 53·5 per cent of the total energy of the current. This value is too high, and the reason is that the heats of formation we have used are those at ordinary temperature, while the reaction takes place at a high temperature with the absorption of less heat. How much less heat is absorbed may be determined by the following considerations:—The amount calculated is the theoretical absorption at ordinary temperatures. It takes 42 per cent of the energy of the current to heat the charge up to the reacting temperature, and yet the products of the reaction, silicon carbide and carbonic oxide, contain much less than that amount of energy as sensible heat; the difference between the heat required to bring the charge up to the reacting temperature and the sensible heat in the products of the reaction at the same temperature, represents the quantity by which the heat absorbed in the chemical reaction has diminished, owing to the higher temperature at which it takes place. Now, the heat in 7000 pounds of silicon carbide is about 7000 × 0·3 × 3000 = 6,300,000 calories; in the 9800 pounds of carbonic oxide 2,200,000 calories, giving a total heat in the products of 8,500 000 calories. Since it took 18,975,000 calories to heat up the charge, the difference, 10,475,000 calories, has disappeared, and has gone towards furthering the chemical reaction. The chemical reaction has therefore absorbed

from outside 24,500,000 − 10,475,000 = 14,025,000 calories = 34·5 per cent of the energy of the current.

Efficiency.—Heating up charge 42 per cent + 34·5 per cent absorbed in the chemical reaction = 76·5 per cent net efficiency.

(To be continued).

PROCEEDINGS OF SOCIETIES.

INSTITUTE OF CHEMISTRY.

The Twenty-fifth Annual General Meeting of the Institute of Chemistry was held at 30, Bloomsbury Square, on Monday, March 2nd, at 4.30 p.m., Professor John Millar Thomson, LL.D., F.R.S., President, in the Chair. The Annual Accounts and the Report of the Auditors having been duly received, Professor Tilden moved the adoption of the Report of the Council, drawing attention to the increase in the members (in spite of heavy losses sustained by death), and also to the increase in the number of candidates for examination, notwithstanding that the Council have, within the last few years, considerably raised the standard of the regulations for admission to the Institute. He also endorsed the warm tribute of appreciation accorded by the Council to the retiring President. Dr. Stevenson seconded the Report, which was then adopted.

Ballot for the election of Censors having been taken, the following were declared elected:—Dr. W. J. Russell, F.R.S.; Dr. Thomas Stevenson, F.R.C.P.; Professor John Millar Thomson, LL.D., F.R.S.; and Professor William Augustus Tilden, D.Sc., F.R.S.

The Meeting proceeded to appoint Auditors, and Messrs. H. Ballantyne, A. R. Ling, and C. H. Cribb were declared elected.

The President then delivered his Address. As the Institute has recently completed a quarter of a century of existence, Professor Thomson submitted a brief history of its work from its foundation to the present time. The Address was divided under definite headings, the first portion being a record of the origin and general progress. The President described how the growing appreciation of the science of analytical chemistry from the utilitarian point of view, led to the necessity for an organisation for maintaining a standard of qualification on the part of analytical and consulting chemists. The real origin of the Institute was a suggestion put forward in 1872, by the late Sir Edward Frankland, at a Dinner given to Professor Cannizzaro on his appointment as Faraday Lecturer. Later, in 1876, he proposed to the Council of the Chemical Society, that a class of Fellows to be styled Licentiates (or some analogous title) should be created for the purpose of distinguishing between competent professional chemists and those who professed an interest in chemistry as a science and not as a means to earning a livelihood. The idea was not adopted, but it was decided to found a new Society, the Institute of Chemistry being formally incorporated under the Companies' Act on October 2nd, 1877.

Among those active in founding the Institute were mentioned Mr. Carteighe, Professor Hartley, the late Mr. Frederick Manning, Mr. Chas. Tookey, and the late Dr. Alder Wright. Professor Thomson himself was also a keen worker for the Institute in its earliest history. He proceeded to relate its progress under the successive Presidents:—Sir Edward Frankland, Sir Frederick Abel, Dr. William Odling, Dr. James Bell, Professor W. A. Tilden, Dr. W. J. Russell, and Dr. Thomas Stevenson. He dealt with the regulations as to training and examination of candidates for the Associateship of the Institute, showing how the standard of the requirements for membership had been steadily raised, and he commented on the consequent increasing recognition of the qualifications "A.I.C." and "F.I.C." by Government and municipal authorities and by the leaders of industry throughout the kingdom.

After reviewing the Conferences on practising and professional questions held from time to time by the Institute, the President referred to the development of the library, and concluding by expressing his personal satisfaction in the nomination of Mr. David Howard as his successor in the Chair.

The Officers and Members of Council for the ensuing year were then declared elected.

The new President being formally inducted, thanked the Fellows and Associates for the honour bestowed on him, and declared the meeting dissolved.

Officers and Members of Council for the ensuing year:—

President—David Howard.

Vice-Presidents—Walter Ernest Adeney, D.Sc.; George Beilby; Frederick Daniel Chattaway, M.A., D.Sc.; Percy Faraday Frankland, Ph.D., F.R.S.; Francis Robert Japp, LL.D., F.R.S.; John Millar Thomson, LL.D., F.R.S.

Hon. Treasurer—Alfred Gordon Salamon, A.R.S.M.

Members of Council—Leonard Archbutt; Edward John Bevan; Bertram Blount; Horace T. Brown, LL.D., F.R.S.; James Cameron; Charles Edward Cassal; Alfred Chaston Chapman; Edwy Godwin Clayton; Edward Divers, M.D., F.R.S.; James Johnstone Dobbie, M.A., D.Sc.; Bernard Dyer, D.Sc.; Thomas Fairley; Alfred John Greenaway; Henry Wilson Hake, Ph.D.; Henry James Helm; Edward William Taylor Jones; Julius Lewkowitsch, M.A., Ph.D.; William Walker James Nicol, M.A., D.Sc.; Frederick James Montague Page, B.Sc., A.R.S.M.; William Henry Perkin, Ph.D., F.R.S.; William Jackson Pope; Henry Richardson Procter; Percy Andrew Ellis Richards; Alexander Scott, D.Sc., F.R.S.; Joseph Wilson Swan, F.R.S.; Leo Taylor; John Augustus Voelcker, M.A., Ph.D.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, March 3rd, 1903.

Mr. Charles Bailey, President, in the Chair.

"*Further Investigation of the Detection and Approximate Estimation of Minute Quantities of Arsenic in Malt, Beer, and Food Stuffs.*" By William Thomson, F.R.S.E., F.I.C.

The author of this paper pointed out that he had greatly improved the process which he had already published (see Chemical News, 1902, vol. lxxxvi., p. 179), and that by this improved method he had been able to obtain a very distinct mirror of arsenic in beer; for instance, when it existed to the extent of $\frac{1}{1000}$th part of a grain per gallon, when working on 50 c.c., which is equivalent to less than a sherry glassful of the beer. This is equivalent to the detection of about one part in two hundred and eighty millions of beer. The refinement in his process depends chiefly on the fact that he heats the naked glass of the tube with a Bunsen flame, the end of which flame heats a piece of copper wire gauze which extends for about a quarter of an inch on to the drawn-out portion of the tube which receives the mirror. Secondly, that the drawn-out portion of the tube is covered with a piece of tissue paper about 1 m.m. distant from the hot wire gauze. The hot wire gauze prevents the formation of a mirror till the liberated arsenic comes in contact with the tube, which is kept cold by a stream of cold water passing over the tissue paper. By this means very minute quantities of arsenic may be easily seen, as they are deposited in a very narrow ring around the cold portion of the tube. He explained the differences which caused the formation of brown metallic mirrors and black arsenic deposits by the subsequent evaporation

of the brown mirrors due to heat, which came in contact with the tube after the brown mirror had been deposited. He showed a method of finding the exact internal diameter of the tube upon which the mirror was to be deposited, and by these combined methods he showed that much greater accuracy could be obtained than hitherto in the estimation of arsenic contained in beer, malt, or food stuffs. He also referred to a curious instance of the fading of mirrors, especially of those which had *not* been formed by the new cooling process when sealed up in an atmosphere of hydrogen. He assumed that this effect was caused by the action of light upon the mirrors.

Professor H. B. Dixon, F.R.S., exhibited an Electrolytic Marsh Apparatus, which had been adopted by the Government authorities for the detection of arsenic, and he claimed that it was sufficiently delicate for the purpose.

Mr. Francis Jones referred to the recent observations on the bending of marble made by Professor See, of Washington, and pointed out that similar phenomena have long been known. Lantern slides were shown of marble tombstones (particularly that of Professor Black) in Edinburgh churchyards, which have fallen to pieces in the course of sixty or seventy years, the marble in each case having bent outwards.

NOTICES OF BOOKS.

A Junior Chemistry. By E. A. Tyler, B.A. London: Methuen and Co. 1902. Pp. 228.

Although many schools are provided with laboratories of a more or less efficient character, the short amount of time that can be set apart for laboratory work prevents most boys learning much practical or experimental work. Lectures by themselves are not of very great use unless they are supplemented by book work and practice. This book is intended to act as that supplement, and will be of much use in assisting the student to acquire a good fundamental knowledge of scientific chemistry.

The first five chapters describe certain physical laws and processes with which the student must be acquainted, such as the properties of matter and their measurement; the influence of temperature and pressure on the volumes of gases; weight and mass, &c. The importance of accurate weighing is insisted on early in the book; and, rightly so, as the value of correct quantitative results cannot be over emphasised. Chapters VI. to X. explain and illustrate the fundamental principles of chemistry, and the remainder of the book is devoted to the study of certain typical elements and compounds.

We are sorry to note the extravagant use the author makes of heavy type and italics; there is not a page where these two methods of emphasis are not used many times. Frequent underlining is always evidence of want of confidence by the writer, who fears that he will not be properly understood; it also gives the book a patchy appearance, and is generally unnecessary.

The Story of Alchemy and the Beginning of Chemistry By M. M. Pattison Muir, M.A. With seventeen illustrations. London: George Newnes, Ltd. 1902. Pp. 185.

Though there is a certain amount of interest in such a book as this, it is not one that should be put in the hands of a young student or beginner, as it would be almost certain to give him, what we know now to be, very distorted ideas on science in general and chemistry in particular.

The story of alchemy is the story of the attempt of philosophers of olden times to account for the material changes they observed, by means of what we might almost call spiritual reasons. In the first place they assumed that all nature was a very simple matter, whereas we know now that it is extremely complex. They attempted to account for the phenomena they observed by the action of four so-called elements—fire, earth, air, and water, with the addition of spirit or essence. "The central quest of alchemy was the quest of an undefined and undefinable *something*, wherein was supposed to be contained all the powers and potencies of life, and whatever makes life worth living . . . it was called the philosopher's stone, the stone of wisdom . . . and many other names were given it." The preceding lines give in a very concise form the principal idea running through all the records of alchemy; perhaps human nature in general is not so very different to-day, the "central quest" is still, as a rule, that of gold.

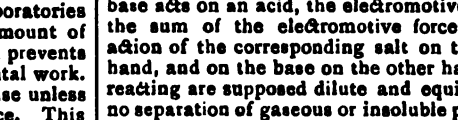
CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

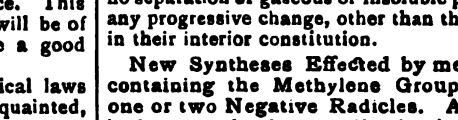
Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 7, February 16, 1903.

Law relating to the Electromotive Forces of Piles depending on the Reciprocal Action of Saline Solutions and Soluble Electrolytes.—M. Berthelot.—The author discovers and proves the following law:—When a base acts on an acid, the electromotive force developed is the sum of the electromotive forces developed by the action of the corresponding salt on the acid on the one hand, and on the base on the other hand. The solutions reacting are supposed dilute and equivalent, and causing no separation of gaseous or insoluble products, nor causing any progressive change, other than that of neutralisation, in their interior constitution.

New Syntheses Effected by means of Molecules containing the Methylene Group Associated with one or two Negative Radicles. Action of Epichlorhydrine on the Acetonedicarbonic Sodium Ethers.—A. Haller and F. March.—In a previous research the authors showed that the product of the action of epichlorhydrine on sodium benzoylacetic ether chiefly consists of



a ketonic lactone having the formula



At the same time, MM. Traube and Lehmann showed that epichlorhydrine forms with sodium acetylacetic ether a compound to which they assign an analogous formula. The acetonedicarbonic ethers contain two methylene groups between the negative radicles, and the authors effect a condensation between these ethers and epichlorhydrine.

Conditions under which Manganese in Acid Solution can be Estimated by Persulphates.—H. Baubigny.—When a solution of an alkaline persulphate is heated, this salt loses oxygen, and is transformed into an acid solution by hydration. If such a solution contains manganese, this formation of free acid does not prevent the separation of the metal in the form of peroxide. The author further investigates the subject to find whether, in a previously acidified liquid, this phenomenon is still possible. His experiments were made in the presence of sulphuric acid, nitric acid, also some organic acids. A list of results is given showing the conditions under which the estimation of manganese is possible.

Heat of Formation of certain Sulphur and Nitrogen Compounds.—Marcel Delépine.—Continuing his re-

searches on the sulphur and nitrogen compounds derived from carbon disulphide, the author compares the thermochemical properties of some of these substances. He uses Berthelot's calorimetric bomb; the heats of formation being calculated from the equation of combustion:—

$$C_nH_mN_pS_q + (2n+\frac{m}{2}+3q)O =$$

$$= nCO_2 \text{ gas} + (\frac{m}{2}-q)H_2O \text{ liq.} + pN \text{ gas} + qSO_4H_2 \text{ sol.}$$

Action of Hydrogen on Silver Sulphide in presence of Sulphides of Antimony and Arsenic.—H. Pélabon.—An investigation of the action of hydrogen on various masses of definite mixtures, such as those corresponding to the formulæ $Sb_2S_3Ag_2S$, $Sb_2S_3.3Ag_2S$, $As_2S_3Ag_2S$, $As_2S_3.3Ag_2S$, show that the relation between the partial pressure of sulphuretted hydrogen and the total pressure of the mixed gases (R) increases regularly with the weight of these mixtures.

Action of Phosphoric Acid on Erythrite.—P. Carré.—Phosphoric acid acts on erythrite in the following manner:—(1) Dehydration takes place, and (2) etherification follows, giving a mono-ether of erythran, which substance can further lose another molecule of water, giving at the same time a di-ether resulting from the etherification of the two phosphoric OH groups by a molecule of erythran.

Preparation of certain Combinations of α-Methyl-α'-isopropyladipic Acid.—C. Martine.—The dimethylic and diethylic ethers of α-methyl-α'-isopropyladipic acid are easily prepared by the action of dry hydrochloric acid on a solution of the acid in anhydrous methyl and ethyl alcohols. The author also prepares the diamide, dianilide, and para toluidide of this acid.

Bulletin de la Société Chimique de Paris.
Series 3, Vol. xxvii., No. 16—17.

Arsenic exists normally in Animals, and is found principally in the Ectodermic Organs.—Armand Gautier.—A controversial paper in which the author defends his previous assertions that arsenic is present in animal organisms.

The Existence of Arsenic in the Organism.—Gabriel Bertrand.—The author upholds M. Gautier's statements that arsenic is present in parts of the animal organism, such as the hair, nails, and skin; he has assured himself that all the reagents used were perfectly free from arsenic, and by repeating M. Gautier's experiments, and making other similar ones, he shows that arsenic is present as stated.

The Detection of very small quantities of Arsenic.—Gabriel Bertrand.—Already noticed.

Alloys of Cadmium and Magnesium.—O. Boudouard.—Already inserted in full.

A Combination of Acetic Acid with Nitric Acid.—Ainé Pictet and P. Genequand.—Already inserted.

The Estimation of Free Anhydrous and Hydrated Lime in Concretes.—M. Maynard.—Already inserted in full.

Action of Isocyanate of Phenyl on the Ethers of some Oxyacids.—E. Lambling.—A continuation of the author's previous papers on the same subject. He describes the action of isocyanate of phenyl on diethyloxalic ether, on benzylic ether, and on salicylate of methyl, and shows that their phenylurethanes do not give the phenylurethanes of the corresponding acids by saponification, but instantly the corresponding anilides according to the equation—

$$\begin{matrix} R_2{=}CO{-}CONH{-}C_6H_5 \\ | \\ CO{-}OH \end{matrix} = CO_2 + \begin{matrix} R{=}COH \\ | \\ CO{-}NH{-}C_6H_5 \end{matrix}.$$

Action of Chlorides and Anhydrides of the Acids of the Fatty Series on Polymerised Methanal.—Marcel Descudé.—Already inserted.

A Method for the Synthesis of Polycyclic Hydrocarbides.—M. Delacre.—To prepare fluorene-carbonic acid, a mixture of one part of trichloracetate of ethyl, ten parts of benzene, and three parts of chloride of aluminium are left at the ordinary temperature for twelve hours; it is then heated on a water-bath so long as hydrochloric acid is given off. Precipitate with water and concentrate the benzenic solution strongly; the addition of ligroïn to the filtered solution causes a fresh deposit of fluorene-carbonic acid. The mother liquors will serve for the preparation of fluorene.

Some Derivatives of β-Naphthylamine.—A. Reychler.—The author describes the preparation and some properties of a number of derivatives of β-naphthylamine; among them are the chlorhydrate of ethyl-β-naphthylamine, the camphor-sulphonate of ethyl-β-naphthylamine, the iodhydrate of diethyl-β-naphthylamine, and some methylised derivatives of β-naphthylamine.

Estimation of Urinary Acidity by Sucrate of Lime.—J. de Girard and J. Vires.—The authors have observed that the addition of sucrate of lime to the solution of monometallic alkaline phosphates gives crystallised bicalcic phosphate. It is concluded that it is this phosphate which is formed by the contact of the two solutions, and that it re-dissolves and remains in solution for a certain time, thanks to the acidity of the solutions. The action of sucrate of lime on the acid phosphates of the alkaline metals can be represented by the following general equation:—

$$nPO_4MH_2 + SCaO =$$
$$= PO_4Ca_2H + PO_4M_2H + (n-2)PO_4MH_2 + SH_2O.$$

Their final conclusion is, however, that sucrate of lime will not serve to determine the acidity of a monometallic phosphate, since the reaction is incomplete to begin with, and it varies with the nature of the metal for the same quantity of phosphoric acid; now urinary acidity is due especially to monometallic phosphates.

New Method of Organic Analysis.—P. Thibault and A. C. Vournasos.—The authors describe a new apparatus for organic analysis and also the method of procedure. The organic matter is, as is usual, burnt with oxide of copper, or with pure peroxide of manganese; they have obtained very good results with various allotropic forms of carbon, as well as with organo-metallic compounds, such as carbonates, oxalates, borates, formates, ferro- and sulphocyanides, &c.

Examination of the Colouring of Animal Fibres by means of Acid Colouring Materials.—P. Sisley.—A long paper not suitable for abstraction.

Mechanism of the Chemical Variations in Plants submitted to the Influence of Nitrate of Sodium.—E. Charabot and A. Hébert.—Already noticed.

MISCELLANEOUS.

Royal Institution.—On Tuesday next (March 17), at 5 o'clock, Sir Robert Ball will commence a course of three lectures at the Royal Institution on "Great Problems in Astronomy"; and on Thursday (March 19), Dr. C. H. Firth delivers the first of three lectures on "Society during the Commonwealth and Protectorate." The Friday Evening Discourse on March 20 will be delivered by Prof. E. A. Schäfer on the "Paths of Volition"; on March 27, by Prof. Herdman on the "Pearl Fisheries of Ceylon"; and on April 3, by Lord Rayleigh on "Drops and Surface Tension."

Sulphide of Cobalt.—W. Herz.—Moist sulphide of cobalt which has not been in contact with the air dissolves in even very dilute hydrochloric acid, whether it has been precipitated hot or cold. When drained it still dissolves in deminormal hydrochloric acid, forming a red solution and giving off sulphuretted hydrogen, but its solubility is much less. If sulphide of cobalt is left for a sufficiently long time in contact with the air, it is transformed partially into sulphate, and consequently loses a portion of its cobalt when shaken up with deminormal hydrochloric acid, or even simply with water. Cobalt will not precipitate with sulphuretted hydrogen on account of the easy solubility of the sulphide in dilute hydrochloric acid. This sulphide, on contact with air, undergoes a transformation (polymerisation) on which the author is at work still.—*Zeit. Anorg. Chemie*, vol. xxvii., p. 390.

Hydroxylamido- and Nitrosoanthraquinones.—L. Wacker.—By reducing 1.2-nitroanthraquinone-sulphonate of sodium in alkaline solution with grape sugar, under the conditions described fully by the author, we obtain 1.2-hydroxylamido-anthraquinone-sulphonic acid, of which the mono-sodic salt is soluble in water, giving a reddish-brown colour, and also the disodic salt, giving a green solution. If we reduce 1.2-nitroanthraquinone-sulphonic acid with sesquioxide of sulphur, we obtain an amido-oxyanthraquinone-sulphonic acid, of which the constitution has been established by its transformation into the green of sulphonised-quinizarine. Now, this same product is formed by the transposition of 1.2-hydroxylamido-anthraquinone-sulphonic acid by means of concentrated sulphuric acid by heating to about 70°—80°. On the other hand, hydroxylamido-anthraquinone-sulphonate of sodium in alkaline solution gives, on oxidation by means of ferricyanide of potassium, nitroso-anthraquinone-sulphonate of sodium.—*Berichte*, vol. xxxv., p. 666.

Oxides of Cobalt.—Erwin Huttner.—Persulphate of potassium gives the following reaction with oxide of cobalt: $2Co(OH)_2 + S_2O_8K_2 + 2H_2O = H_2SO_4 + K_2SO_4 + Co_2(OH)_6$. Other oxides may be formed according to the conditions of the experiment; for example, $3Co_2O_3.5H_2O$ and $Co_2O_3.2H_2O$, analogous to the hydrates given by oxide of iron. With $S_2O_8Am_2$ in acid solution the sesquioxide of cobalt obtained is anhydrous; in alkaline solution we obtain the hydrated oxide. Chlorine and the hypochlorites give an oxide in which the ratio $\frac{O}{Co}$ is decidedly above 1·5.

Oxidation by means of iodine appears, without any doubt, to lead to the formation of a peroxide, CoO_2. Electrolytic oxidation of the salts of cobalt always furnishes sesquioxide. All these oxides dissolve in hydrochloric acid with the evolution of chlorine. The solutions are red when hot, and blue when cold. Nitric and sulphuric acids dissolve them less easily with the evolution of oxygen. With oxalic acid we obtain a green solution, and at the same time carbonic acid is given off. On boiling, the solution takes a yellowish-brown colour, and finally becomes red. Acetic acid dissolves the oxides of cobalt very easily, forming a yellowish-brown solution. This latter is not modified either by the addition of ammonia or of an alkali.—*Zeit. Anorg. Chem.*, vol. xxvii., p. 81.

Quantitative Estimation of Bismuth by Electrolysis.—K. Wimmenhauer.—The author made use of very feeble currents from an accumulator, and measuring instruments by Siemens and Halske, and Hartmann and Braun. His variable resistance was a trough of water with moveable lead plates. The water was made slightly conducting by means of sulphuric acid. The electrolysis was made in the well-known Classen apparatus of about 200 c.c. capacity. The anode consisted of a cylindrical electrode of 70 square c.m. surface, kept in movement by means of a small water turbine. The methods already described do not give very good results, but bismuth is precipitated very nicely (about 0·4 grm.) by using a solution containing from 0·5 to 1 c.c. of concentrated nitric acid for each 0·1 grm. of Bi_2O_3 with a current of 0·05 ampère and 2 volts. The time allowed should be three or four hours, keeping the temperature at about 50°. If we wish to shorten the time of the operation, we can commence with a current of 0·1 ampère, but as soon as the deposit commences to take a brown colour, the current must be reduced to 0·05 ampère. The deposited bismuth must be washed, without interrupting the current, with pure water, then alcohol and ether. If we start with nitrate of bismuth, we can easily effect its solution by making use of a mixture containing two parts of water and one of glycerin. For instance, we take 0·1 to 0·3 grm. of the nitrate and dissolve it in 2 to 4 c.c. of the above mentioned liquid. Dilute to 150 c.c., and electrolyse as described.—*Zeit. Anorg. Ch.*, vol. xxvii., p. 1.

NOTES AND QUERIES.

*** Our Notes and Queries column was opened for the purpose of giving and obtaining information likely to be of use to our readers generally. We cannot undertake to let this column be the means of transmitting merely private information, or such trade notices as should legitimately come in the advertisement columns.

The Chemistry of the Colouration of Coins.—Could any of your readers kindly tell me whether there are any essays or works dealing with the colourations and characteristics of old coins; or give me any information bearing upon the chemical effects of time or burial in certain earths upon coins, and the possible variations of such effects as determined by the composition of the coins.—S. Archibald Vasey.

MEETINGS FOR THE WEEK.

Monday, 16th.—Society of Arts, 8. (Cantor Lectures). "Hertzian Wave Telegraphy in Theory and Practice," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S.
—— Society of Chemical Industry, 8. "The Standardisation of Analytical Methods," by H. Droop Richmond, F.I.C., F.C.S. "The Standardisation of Commercial Methods of Analysis, especially those applied to Brewing Materials," by Arthur R. Ling, F.I.C., F.C.S.

Tuesday, 17th.—Royal Institution, 5. "Great Problems in Astronomy," by Sir Robert Ball, F.R.S.
—— Society of Arts, 4.30. "Artistic Fans," by Miss Hannah Falcke.

Wednesday, 18th.—Society of Arts, 8. "New Aspects of Life Assurance," by William Schooling.
—— Microscopical, 8. "The Helmholtz Theory of the Microscope," by J. W. Gordon.
—— Chemical, 5 30. "Essential Oil of Hops" and "On a Compound of Dextrose with Hydroxide of Aluminium," by A. C. Chapman. "Action of Phosphorus Haloids on Dihydroresorcins—Part II., Dihydroresorcin," by A. W. Crossley and P. Haas. "On the Constitution of Cotarnine," by J. J. Dobbie, A. Lauder, and C. K. Tinkler. "Decomposition of Mercurous Nitrite by Heat," by P. C. Ray and J. N. Sen.

Thursday, 19th.—Royal Institution, 5. "Society during the Commonwealth and Protectorate," by Charles Harding Firth, M.A.

Friday, 20th.—Royal Institution, 9. "The Paths of Volition," by Prof. E. A. Schäfer, LL.D., F.R.S.

Saturday, 21st.—Royal Institution, 3. "Light—its Origin and Nature," by Lord Rayleigh, F.R.S., &c.

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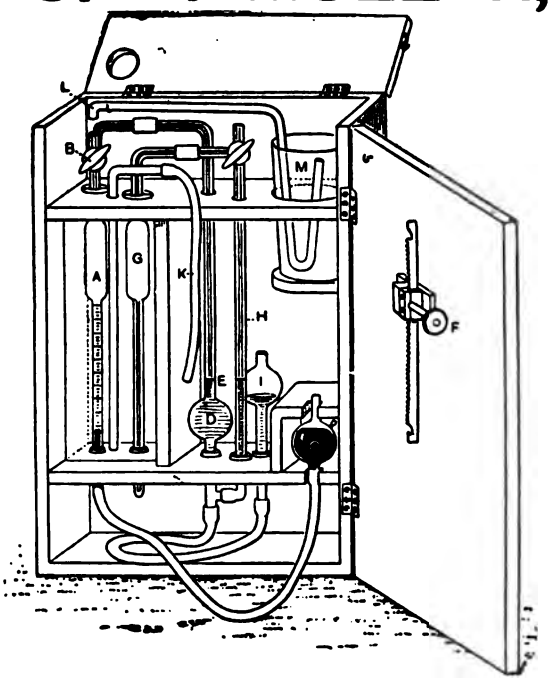

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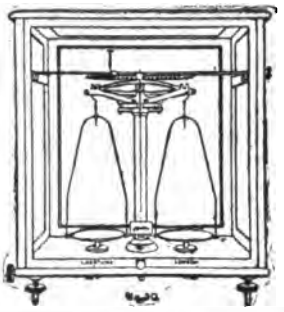

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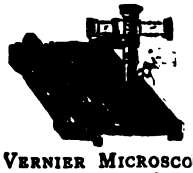

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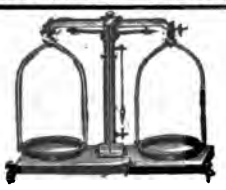

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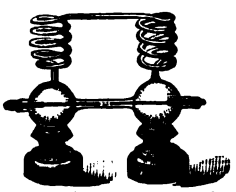

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THE CHEMICAL NEWS.

VOL. LXXXVII., No. 2260.

ON POLONIUM.

By F. GIESEL.

THE small quantities of bismuth which may be obtained from the lead separations of the uranium minerals (*Berichte*, 1900, xxxiii., 1667), at first emit penetrating (β) rays, to about the same extent as a barium salt containing about 5 per cent of radium. It is already known that after some time these rays gradually disappear, until only a residual effect remains. I have shown (*Berichte*, 1902, xxxv., 3610) that from such bismuth Marckwald's substance may be derived, which only yields the (α) rays which can be absorbed.

It was interesting to observe whether also the method of purification described by Mdme. Curie (*Physik. Zeit.*, 1903, viii., 234) for her polonium might be used with the same result as Marckwald's method on my fresh polonium. This is actually the case. If, for example, the hydroxide is treated with a sufficient excess of nitric acid, sometimes a small quantity of yellowish flakes remains undissolved; these phosphoresce, and only give α-rays. From the filtrate, by repeated fractional precipitation with water, bismuth sub-nitrate may be obtained, and the most difficultly soluble fractions become more and more like Marckwald's substance; the precipitates from the mother-liquor, on the contrary, give finally only β-rays. Fractional precipitation with metallic magnesium acts similarly. If the chloride is evaporated to dryness on the water-bath the mass becomes blackish, and on solution in hydrochloric acid brownish-black flakes remain undissolved; these emit α-rays very strongly. But the separations are not so complete as when Marckwald's beautiful method with metallic bismuth* is employed. If a fragment of bismuth is placed in a solution of the chloride previously purified by Curie's method, even after some days no trace of a precipitate appears, and no colouration can be perceived on it. The effect is all the more surprising. The piece of bismuth phosphoresces, ozonises the air, and when it is placed on the zinc sulphide screen the immediate surroundings radiate as strongly as the barium platinum cyanide screen owing to pure radium.

If older preparations of polonium are examined in the same way the same results are obtained, but the products are of less value. This leads me to the supposition that the α-radiation also of the substance is not constant.

I have not demonstrated the presence of tellurium, nor yet succeeded in purifying the substance with zinc chloride. Nor have I been able to observe anything which would suggest that the polonium preparations (with α-radiation) prepared by different methods are not qualitatively identical; they only differ quantitatively owing to varying adulteration with inactive substances, or with those rendered active by induction (bismuth).

I might mention that the two separations of my polonium, whose rays are called α- and β-rays respectively, may be distinguished by the aid of the zinc sulphide screen and the ordinary barium platinum cyanide screen.† The α-radiation only acts on the former, and the β-radiation on the latter.

The β-radiation of radium behaves differently, for it affects both screens.—*Berichte der Deutsch. Chem. Ges.*, 1903, xxxvi., 728.

* Similar results may be obtained in less degree with platinum and gold, and better with palladium than with bismuth; but it is questionable whether analogous reactions occur.

† An unvarnished barium platinum cyanide screen is also affected by the α-radiation, but the zinc sulphide screen is far more sensitive.

THE REDUCTION OF VANADIC ACID BY THE ACTION OF HYDROCHLORIC ACID.*

By F. A. GOOCH and L. B. STOOKEY.

BUNSEN (*Liebig's Ann. Chem.*, xcvi., 265) and Mohr ("Titrirmethode," v. Aufl., 314) have proposed to estimate vanadic acid by the action of concentrated aqueous hydrochloric acid, thus reducing it from the condition of oxidation represented by the pentoxide to that of the tetroxide, in accordance with the equation—

$$V_2O_5 + 2HCl = V_2O_4 + H_2O + Cl_2,$$

and determining iodometrically the chlorine evolved.

In an attempt by Czudnowicz (*Ann. Phys.*, cxx., 17) to make use of this reaction by collecting in standard arsenious acid the chlorine evolved from the boiling mixture of hydrochloric acid and vanadic acid, and titrating the excess of the arsenious acid by iodine, accordant results were not obtained. On the other hand, Gibbs (*Proc. Amer. Acad.*, x., 250) was able to determine with a fair degree of accuracy the small amounts of vanadium pentoxide found in the vanadio-tungstates and other complex combinations, by boiling with strong hydrochloric acid, collecting in potassium iodide the chlorine evolved, titrating the freed iodine with sodium thiosulphate, and calculating from the amount of iodine thus found the vanadium pentoxide corresponding to a change of condition from V_2O_5 to V_2O_4.

Milch (Inaug. Dissert., Berlin, 1887, 10) was unable to substantiate the work of Gibbs, and, obtaining in four experiments, upon approximately 0·2 grm., 0·5 grm., and 1·0 grm. of vanadium pentoxide, amounts of chlorine varying with the quantity of material handled, and never exceeding one-fourth of the amount demanded by theory, was led to suppose that the degree of reduction was not constant, being larger in proportion as the quantity of pentoxide used was smaller. Milch concluded that while accordant results might be obtained by working with approximately similar amounts of material, the process afforded no ground for the calculation of the actual amount of pentoxide present.

Rosenheim (Inaug. Dissert., Berlin, 1888; *Liebig's Ann. Chem.*, ccli., 197) also tested the process, working with pure vanadates and pure vanadium pentoxide. Concentrated hydrochloric acid, of sp. gr. 1·19, was employed, and care was taken to dry the distillation flask before introducing the materials, because even slight dilution of the acid lessened the evolution of chlorine in marked degree. Three stages were noted in the action of hydrochloric acid upon vanadic acid. The vanadic acid first dissolved to a solution of a deep brown colour without perceptible evolution of chlorine; upon warming, the solution suddenly evolved chlorine and took on a deep green colour; thereafter the evolution of chlorine became weaker, and the solution, giving off a small amount of chlorine on strong boiling, assumed a clear blue colour. After this, further heating effected no change. It is recommended to raise the temperature gradually, in order that the acid may not boil over into the receiver, and to keep this receiver cool so that iodine may not be volatilised by steam from the flask during the prolonged heating. In the experiments with ammonium vanadate, in which the heating was interrupted after the first violent evolution of chlorine, the iodine found in the receiver indicated, according to Rosenheim's figures, about 50 per cent of the vanadium pentoxide present; in three experiments longer continued, the indications advanced about 6 per cent; and in three experiments continued presumably to the end—to the appearance of this blue colour—the amounts of pentoxide indicated were 61·77 per cent, 63·71 per cent, 61·89 per cent of the quantities actually taken, and further heating with another receiver until

* Contributions from the Kent Chemical Laboratory of Yale University. From the *American Journal of Science*, vol. xiv., No. 83.

almost all the hydrochloric acid had been volatilised, resulted in no further progress in the reaction. Experiments with potassium vanadate and with vanadium pentoxide resulted similarly. Rosenheim draws the inference that a titrimetric method based upon a theory of reduction from V_2O_5 to V_2O_4 by the action of hydrochloric acid must lead to false conclusions, and suggests that his results lend probability to the supposition that an oxide of the formula $(V_2O_4)_2V_2O_5$ is formed, although the actual reductions observed by him are not quantitatively in accord with the formation of such a body—which implies a reduction covering about 66 per cent of the interval between V_2O_5 and V_2O_4. Rosenheim concludes that the whole method is to be rejected in quantitative estimations. An inspection of Rosenheim's tables, however, shows that the standards of the solutions of thiosulphate and iodine have been interchanged either in the printed record or in the calculation of results. In the latter event, the actual indications of the process would be about 15 per cent higher than Rosenheim's figures, but still approximately 20 per cent below the theory of the reduction from V_2O_5 to V_2O_4.

In Holverscheit's hands the process gave results most irregular and unsatisfactory (Inaug. Dissert., Berlin, 1890). Ammonium vanadate was the material taken for the experiments, and the residue obtained by treating this salt with potassium hydroxide and evaporating to expel ammonia, was boiled in a Bunsen distillation apparatus with concentrated hydrochloric acid. The solution, at first yellow, became green on long boiling. In some cases ebullition was kept up for fifteen minutes. In working with amounts of material represented by 0·0585 grm., or 0·1171 grm. of V_2O_5, Holverscheit obtained from about 28 per cent to 39 per cent—or, in the average, about a third of the theoretical reduction—and, while noting the fact that by working with wholly concentrated ("ganz. konz.") HCl Rosenheim doubled this yield, ventures the opinion that it is scarcely conceivable that Gibbs obtained by boiling vanadic acid with hydrochloric acid and estimating the chlorine liberated, results even approximating the truth.

The green colour of Holversheit's residual solution shows, of course, an incomplete reduction—the consequence of the use of an acid which, as intimated, was not of full strength. Rosenheim, however, got the blue residual solutions characteristic of the condition of oxidation corresponding to V_2O_4. Why the deficiency in the chlorine indicated in the receiver in Rosenheim's experiments was so marked is not obvious, unless it be supposed that chlorine was lost from the apparatus in the sudden evolution which takes place when action begins. Our experience, moreover, shows that the liberation of chlorine begins as soon as the hydrochloric acid and vanadic acid come into contact. In our experiments upon the process, therefore, we have used a form of apparatus such that no chlorine can be evolved before the apparatus is connected and ready. For the retort we have used a Voit flask upon the inlet tube of which was sealed a stoppered funnel, while the outlet tube was sealed to a Drexel wash-bottle, and this in turn was joined to Will and Varrentrapp bulbs. The Drexel bottle and bulbs used as receiver and trap were charged with water containing 3 grms. of potassium iodide; the vanadate was introduced into the dry flask, and the apparatus was adjusted. Hydrochloric acid was put in the stoppered separating funnel and, when all was ready, allowed to run into the flask. Connection was made between the funnel and a carbon dioxide generator, so that by passing carbon dioxide through the apparatus all danger of regurgitation might be avoided. Sometimes n the course of our work, too, a branched connection with the funnel tube was so arranged that either hydrochloric acid gas or carbon dioxide, or both, might at pleasure be sent into the apparatus. We have used in the experiments to be detailed ammonium vanadate either purchased in pure condition or made by precipitation with alcohol, or prepared from the oxychloride obtained by acting with chloroform upon ignited vanadium pentoxide. In each case the content in vanadium pentoxide was determined by ignition and confirmed by Holverscheit's bromide process (Inaug. Dissert., p. 48).

In Table I., A, are gathered results obtained by the use of the ordinary pure hydrochloric acid of the laboratory of sp. gr. 1·17; while in B of the same table are recorded results got by using acid of sp. gr. 1·20, specially prepared by saturation of the former acid, kept cold by ice, with hydrochloric acid gas.

In these experiments, in which the precautions described to catch all the chlorine evolved were taken, the actual registration of chlorine amounts in the average to 92·62 per cent of the theory when the ordinary pure acid of the laboratory of sp. gr. 1·17 was used, and to 94·46 per cent when the specially concentrated acid of sp. gr. 1·20 was employed. While the error of these determinations would amount to a considerable figure when large amounts of vanadic acid are to be determined, it is obvious that a correction of, let us say, 6 per cent or 8 per cent upon the small proportions of vanadium pentoxide present in many of the complex salts to which Gibbs applied this method, would not change the significance of the analysis. Indeed, reference to the original shows that the formulæ deduced by Gibbs would in many cases apply as well to the corrected results as to the original figures. Thus it appears that, so far as concerns the special cases, in which Gibbs used this method of analysis, the conclusion of Milch that the process affords no ground for the calculation of the amounts of pentoxide present, and Holverscheit's difficulty in supposing that results were even approximately true, prove to be unfounded, while Rosenheim's supposititious oxide disappears.

In the light of these results it is of interest to note the effect of a repetition of this treatment with strong acid of the residue of the first action weakened by boiling. Plainly two methods of bringing about the re-treatment with strong acid are open: either the weak acid remaining after the boiling process may be wholly removed by evaporation and replaced by concentrated acid, or it may be cooled and re-saturated with gaseous acid. Table II. contains the record of results obtained in both these ways.

These experiments show very clearly that several successive treatments with strongest hydrochloric acid, consisting either in the addition of the concentrated aqueous acid to the dry residue in successive portions, or in passing gaseous acid through the residual liquid cooled in ice-water, finally bring the residue to a condition of reduction in which the re-charging of the liquid residue with gaseous acid produces no brown or green colour, but a clear blue. When this condition is reached the Holverscheit procedure produces no appreciable further reduction. The holding of the blue colour when the solution cooled in ice-water is thoroughly charged with the gaseous acid, appears to be the best evidence of the complete reduction of V_2O_5 to V_2O_4; it is not sufficient that the boiled solution, in which the acid has been weakened, should be blue.

In the several manipulations of the repeated processes there is likely to be some mechanical loss of chlorine. For this reason, the direct titration of the residues by potassium permanganate in presence of a manganous salt was combined, as a control, with the determinations of the iodine set free by chlorine in the distillate, as shown in the experiments of Table III.

In these experiments we have again evidence that it is possible to effect the reduction of vanadic acid to within a few per cent of the amount present by a single treatment with concentrated hydrochloric acid, and that the amount of the reduction may be determined by titrating the residue with potassium permanganate. It is plain, therefore, that Gibbs's application of this mode of reduction and titration to the determination of the small proportions of vanadium pentoxide found in many of the complex salts studied by him is also justified.

The experiments show also that when the action of hydrochloric acid is sufficiently continued, ordinarily large

TABLE I.

NH_4VO_3 taken. Grm.	HCl taken. C.m.s.	V_2O_5 by calculation. Grm.	V_2O_5 found. Grm.	Error in terms of V_2O_5. Grm.	Per cent.	Details of treatment.
			A.			
0·0500	20 (sp. gr. 1·17)	0·0387	0·0348	0·0039	10·08	Boiled five minutes to blue colour.
0·1000	40 ,, ,,	0·0765	0·0709	0·0056	7·32	
0·1000	40 ,, ,,	0·0765	0·0714	0·0051	6·67	
0·1000	40 ,, ,,	0·0765	0·0705	0·0060	7·84	
0·3000	30 ,, ,,	0·2295	0·2125	0·0170	7·41	Boiled to blue colour.
0·3000	25 ,, ,,	0·2295	0·2179	0·0116	5·06	
			B.			
0·1000	30 (sp. gr. 1·20)	0·0765	0·0716	0·0049	6·41	Boiled to blue; brown when re-saturated.
0·1000	30 ,, ,,	0·0765	0·0732	0·0033	4·31	
0·1000	30 ,, ,,	0·0765	0·0734	0·0031	4·05	
0·1000	30 ,, ,,	0·0765	0·0734	0·0031	4·05	
0·1000	25 ,, ,,	0·0765	0·0711	0·0054	7·06	
0·1000	25 ,, ,,	0·0765	0·0709	0·0056	7·32	

TABLE II.

NH_4VO_3 taken. Grm.	HCl taken. C.m.s.	V_2O_5 calculated. Grm.	V_2O_5 found. Grm.	Error. Grm.	Details of treatment.
0·1000	10 (sp. gr. 1·20)	0·0752	—	—	Evaporated to dryness. Residue brown when treated with concentrated HCl.
	5* ,, ,,	0·0752	—	—	
	5* ,, ,,	0·0752	0·0737	0·0015	
0·1000	40 ,, ,,	0·0752	0·0700	0·0052	Boiled fifteen minutes.
	—	0·0752	—	—	Evaporated to dryness. Residue treated with KBr gave Br equivalent to 0·0001 V_2O_5.
	7* ,, ,,	0·0752	—	—†	
	7* ,, ,,	0·0752	—	—†	
	7† ,, ,,	0·0752	0·0742	0·0010†	
0·1000	40 ,, ,,	0·0752	0·0699	0·0053* (*a*)	Boiled—(*a*) twenty minutes, (*b*) five minutes, (*c*) five minutes. Residue blue with concentrated HCl or with KBr gave Br equivalent to 0·0004 V_2O_5.
	Gas‡	0·0752	0·0733	0·0029† (*b*)	
	Gas†	0·0752	0·0751	0·0001† (*c*)	

* Brown. † Blue. ‡ Green.

TABLE III.

NH_4VO_3. Grm.	Aq. HCl. C.m.s.	V_2O_5 calculated. Grm.	V_2O_5 found by chlorine in distillate. Grm.	Error. Grm.	V_2O_5 found by $KMnO_4$ as residue. Grm.	Error. Grm.
0·1000	25 (sp. gr. 1·20)	0·0765	—	—	0·0740 (*a*)	0·0025 −
0·1000	25 ,, ,,	0·0765	—	—	0·0736 (*a*)	0·0029 −
0·1000	25 ,, ,,	0·0765	—	—	0·0744 (*a*)	0·0021 −
0·1000	30 ,, ,,	0·0765	0·0711	0·0054	— (*a*)	—
	Gas (*c*)	—	0·0734	0·0031	0·0758 (*b*)	0·0007 −
0·1000	25 ,, ,,	0·0765	0·0714	0·0051	— (*a*)	—
	Gas (*c*)	—	0·0746	0·0019	— (*a*)	—
	Gas (*c*)	—	0·0765	0·0000	0·0765 (*b*)	0·0000
0·3000	25 ,, ,,	0·2295	—	—	— (*a*)	—
	Gas (*c*)	—	—	—	— (*a*)	—
	Gas (*c*)	—	—	—	0·2284 (*b*)	0·0011 −
0·3000	25 ,, ,,	0·2295	0·2259	0·0036	— (*a*)	—
	Gas (*c*)	—	0·2288	0·0007	0·2302 (*b*)	0·0007 +
0·3000	25 (sp. gr. 1·17)	0·2295	0·2207	0·0088	— (*a*)	—
	Gas (*c*)	—	0·2244	0·0051	— (*a*)	—
	Gas (*c*)	—	0·2258	0·0037	— (*a*)"	—
	Gas (*c*)	—	0·2269	0·0026	— (*a*)	—
	Gas (*c*)	—	0·2281	0·0014	0·2293 (*b*)	0·0002 −

(*a*) Residue after boiling was blue.
(*b*) Residue blue after boiling was still blue when re-saturated.
(*c*) Residue was cooled in ice-water and re-saturated with gaseous HCl.

amounts of vanadic acid may be completely reduced to the condition of the tetroxide; and the method of reduction is of special advantage in those cases which call for titration of the tetroxide by permanganate, since in such cases the use of Holverscheit's admirable method of reduction by hydrobromic acid is precluded.

THE EFFICIENCY OF ELECTRIC FURNACES.*

By JOSEPH W. RICHARDS.

(Concluded from p. 128).

Heating with Fusion and Chemical Reaction.

There are numerous instances of this kind of electric furnace operations, in which, particularly, reductions to metal or other metallic compounds are operated. The United Barium Co.'s process is a good instance, barium sulphate being mixed with a small amount of carbon and the charge reduced to a mixture of barium sulphide and oxide in the electric furnace. The calculations, however, are complicated by the fact that the chemical reaction absorbs very much less heat at the furnace temperature than that calculated at the ordinary temperature, as is known from the fact that the efficiency calculated without reference to that factor runs over 100 per cent. The specific heat of the product is unknown, as well as its composition being variable, so that it is impossible at present to allow for the correction required.

The production of calcium carbide presents some interesting data, and may be employed to illustrate this class of operations. Assuming an output of 4 tons per 1000 horse-power per day, or 250 horse-power days per ton, the temperature 2750° C., and using the heats of formation at ordinary temperature, we have:—

Heat energy of current, 250 horse-power per day = 7,200,000 pound calories.

Absorbed in heating charge, 2000 pounds of lime = 2000 × 0·25 × 2750 = 1,375,000 calories; 1500 pounds of coke = 1500 × 0·5 × 2750 = 2,062,500. Sum, 3,437,500 calories.

Absorbed in chemical reaction:—In the formation of 64 parts of carbide, the heat balance is as follows:—

Decomposition of 56 parts of lime ..	—	130,500 cals.
Formation of 64 parts of carbide.. ..	—	7,250 ,,
Heat absorbed..	—	137,750 ,,
Formation of 28 parts carbonic oxide ..		29,400 ,,
Net heat absorbed	—	108,350 ,,
Absorbed per unit of carbide		1,690 ,,
Absorbed per ton of carbide		3,380,000 ,,

This figure may be too high, like that calculated for formation of carborundum, but we do not have the data to make further corrections. The sum total of the heat required to heat up the charge and that absorbed in chemical reactions is 6,817,500 calories, or nearly 95 per cent, which is certainly too high. An assumption of a probable value for the specific heat of the carbide would change the figures materially, making the heat absorbed in the reaction only 14 per cent of the whole heating effect, which added to the 48 per cent required to heat up the charge gives a net efficiency of 62 per cent.

There is a distinct experimental gap in the lack of knowledge of the specific heat of these products of the electric furnace at high temperatures. When these are known, our calculations can be made with much greater exactness.

The net result, however, seems to point to a commercial efficiency of 60 to 75 per cent, calculating, as I have indicated, with furnaces of 200 to 1000 horse-power. The value of such an approximate figure is, that any one starting an electric furnace operation should be able to calculate the approximate output to be expected; or, if planning or designing for a given output, will have a guide to indicate the approximate size and capacity of the furnaces needed.

I have left out of consideration the cases where electrolysis takes place, using fused electrolytes, because in these the production is proportional to the ampères of current used, and not to the total energy of the current, and can be operated only with direct current. Such are essentially strictly electrolytic processes, in which the heating effect of the current is unavoidable and incidental to the main process of electrolysis, and such must be excluded from the term "electric furnace processes" if that term is to retain its individuality and stand for a definite class of operations.

The considerations of such electrolytic operations on fused salts may be carried out in a similar manner to the above calculations, using the energy absorbed in the electrolytic decomposition and secondary reactions as energy rendered latent and utilised. I have worked out, as an example, the electrolysis of fused sodium chloride by the Acker process as follows:—

8200 ampères are passed through a pot electrolysing 36·5 pounds of sodium chloride per hour. The drop of potential is 6·5 volts, of which 3·5 are absorbed in electrolytic decomposition. We can therefore say at once that $\frac{3·5}{6·5} = 54$ per cent of the energy of the current is usefully applied to decomposition of the electrolyte. In addition to this 36·5 pounds of salt must be melted per hour. The whole energy of the current, 8200 ampères by 6·5 volts drop, is equal to 85,300 pound calories per hour. The salt requires the following heat per pound to melt it and bring it to 850°.

To bring to melting-point 775°, 0·25 × 775	=	143·5 cals.
Latent heat of fusion..	=	40·0 ,,
To bring up to 850°, 0·3 × (850—775) ..	=	22·5 ,,
Total per pound of salt	=	206 0 ,,
Totol per 36·5 pounds of salt	=	7,519 cals.

This quantity is therefore $\frac{7,519}{85,300} = 9$ per cent of the total heat of the current.

Efficiency.—The sum of 9 and 54 gives 63 per cent of the energy of the current usefully applied; the other 37 per cent is lost by radiation. Of the total heat actually generated by the resistance of the electrolyte, $9 \times \frac{6·5}{3} = 19·5$ per cent is absorbed in melting the freshly added salt, and 80·5 per cent is lost by radiation and in the hot products.

Discussion.

Mr. Carl Hering—Mr. Chairman, I am glad that Professor Richards has called attention to this important term, efficiency, because it seems to me that it is often used very loosely, and unless there is an explanation of what is meant by the term in any particular case, the figures will mean absolutely nothing, or almost nothing, because the term efficiency can be applied to various stages of the process. The proper meaning of efficiency is the actual divided by the theoretical amount of energy, but the trouble with furnaces is that frequently we do not know what the theoretical amount is. In many cases it has not been determined, and in other cases it has been determined only roughly. I believe I am correct in saying that for calcium carbide the actual figure is not yet definitely known, unless it has been determined very recently. There is another way in which the efficiency of a furnace can be stated, in which it is perfectly safe to use the term; namely, to say that the efficiency of a certain furnace is so-and-so many pounds of the final pro-

* A Paper read at the Second Meeting of the American Electrochemical Society, Niagara Falls, N.Y., September 15th, 1902. From the *Transactions of the American Electrochemical Society*, ii., p. 51.

duct per kilowatt hour. This is, perhaps, a loose way of using the term efficiency, but it is a practical way, and whenever the theoretical figures are not known, it seems to me that it affords a very good way of stating the efficiency of furnaces when you want to compare different ones for doing the same work. This use of the term is analogous to its use in connection with incandescent lamps; there also we do not know the theoretical light equivalent, so we speak of the efficiency of an incandescent light as being so-and-so many candles per watt, or watts per candle.

Much can often be learned if we analyse the efficiencies of various parts of the process in a furnace. In many cases heat is actually absorbed in the formation of the compound, as, for instance, in the formation of calcium carbide heat is absorbed, so to speak; that is, energy is being stored up in the final product. This is a very important factor in calculating efficiencies.

There is one term in connection with the measurements of the efficiency of certain furnaces which it is very difficult to include, because one cannot measure or calculate it. It occurs in resistance furnaces in which the current passes through the material itself, and is due to the loss by the conduction of current through the lining of the trough, which is generally fire-brick. It is known that fire-brick at a certain temperature will conduct current; that this is a leakage current which causes no electrolysis of the compound but merely supplies heat; the trouble is, that one cannot measure or calculate the amount.

Prof. W. D. Bancroft—If I understood Professor Richards rightly, it appears that he counts in the heat of fusion in making his calculations in regard to efficiency. Now, the heat of fusion, of course, is a factor in considering the length of time necessary for the furnace to heat up to the equilibrium temperature under a given current, but it does not seem to me that it has anything to do with the final temperature that has been reached, because that final temperature is simply a question of the actual radiation at that temperature; the mass is fused, and the amount of heat necessary to fuse it does not come in in determining the equilibrium temperature.

Prof. Hart—Mr. Chairman, I would like to call attention to one fact. We start out in the application of electric energy with a tremendous handicap, where it is not made, as here, by water-power. In many cases it cannot be made by water-power. Take nitric acid: it is impossible to transport nitric acid cheaply a long distance. It is necessary, therefore, to make it on the spot. You cannot get the water-power, for example, in Pittsburg, and there you start in with a tremendous handicap. This is a question which will well bear very thorough investigation, because upon the successful utilisation of collectible energy where a high percentage of the energy is obtained, largely depends the future of electricity.

Mr. Whitney—Mr. Chairman, I should like to learn, if possible, what experiments have been made to reduce this loss of approximately 40 per cent of the energy, which, as I understand it, is the loss through radiation, as I am interested in knowing how much that may possibly be reduced by building the retaining walls of the furnace in such a way as to leave small air chambers throughout the wall.

Dr. Haber—I am interested in learning what numbers you use for the output of calcium carbide; what number of killowatt hours do you use in the calculations per ton of carbide produced?

Prof. Richards—I would say in reply to Mr. Hering, that the term efficiency has two meanings, according to whether it is a continuous operation or a discontinuous one. That is, it may have two shades of meaning. In a continuous operation it represents the melting of the substance added and that absorbed in chemical decomposition. The relation of those two factors to the total would be the efficiency. In a discontinuous operation like the manufacture of graphite, you have simply the heating-up of the material to the final temperature. What heat is radiated after the operation stops, in a discontinuous operation, I would account as heat which had been usefully applied, and not as radiated heat that is totally lost, whereas in a continuous operation all that is lost by radiation is a total loss.

In the manufacture of calcium carbide I have taken a production of four tons per day per thousand horse-power as the basis of my calculation.

With regard to the loss in the lining of the furnace, that was illustrated in the loss in the packing around articles to be graphitised. For instance, the current is passed through the articles to be graphitised, but they must be covered up with a heat insulating material in order to bring them up to a proper temperature, and the lining of the furnace, if the packing may be so-called, in that case absorbed, I think, 30 per cent of the energy of the current. But in the case of the current passing through the substance itself, and not through the lining, as in the case of a non-conducting lining, that amount, I think, is usually small. The conductivity of the charge increases greatly with the high temperature, more rapidly than the conductivity of the lining, which is not heated to so high a temperature, and the ratio of the current going through the charge to that going through the lining is, in my experience, large. In one furnace on which I made experiments and calculations, 96 per cent of the current went through the charge material, while only 4 per cent went through the lining of the furnace. In regard to Professor Bancroft's remark about the heat of fusion in the continuous operation, for instance in the Acker process, where salt is continually added in solid form, it has to be heated, melted, and brought up to the temperature of the furnace, and its latent heat of fusion as well as its specific heat in the solid and liquid stages, will have to be brought into the calculation in order to get the total heat used for liquefying the materials charged.

The idea has often come to me, as to an electric furnace, to look at it as if it were Pegasus hitched to a cart. You have a source of very intense and high temperature, but you can keep that temperature down by regulating the supply of materials, and the temperature can be kept within moderate limits by a rapid charging and discharging of materials from the furnace, so that it is quite possible to conduct an electric operation at ordinary furnace temperature, keeping it down by simply putting a load on it; that is, by charging and discharging the furnace rapidly. I think that principle can be made use of with very fruitful results in chemical operations which we want to take place at a comparatively low temperature.

Replying to Mr. Whitney, I have no experience with regard to making walls hollow or attempting to reduce the radiation in that way. I think the increase of the size of the furnace, where practicable, is the far better way of decreasing relatively the amount of radiation, increasing the size of the furnace and the rate at which the furnace works, and you thus decrease relatively very rapidly the amount of heat lost by radiation. It is like working a steel furnace fast or slow. By working a furnace fast you can reduce the relative amount of loss by radiation and increase the efficiency very greatly.

Pure Iodine.—A. Ladenburg.—Pure iodine, for the determination of the atomic weight, was prepared in the following manner:—Precipitated iodide of silver was left to digest for twenty-four hours with concentrated ammonia, to remove all traces of chloride or bromide of silver, and then by means of zinc it was converted into iodide of zinc, and the iodine, extracted from this latter by means of nitrous acid, was distilled in a current of steam. The iodine prepared in this manner appeared to be a little blacker and less volatile than ordinary iodine; it boiled at 183·5°, fused at 116·1°, and its specific gravity was 4·933.—*Berichte*, vol. xxxv., p. 1256.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, March 5th, 1903.

Dr. W. H. PERKIN, F.R.S., Vice-President, in the Chair.

MESSRS. Brincker, Howorth, Beanes, J. E. Mackenzie, Cousins, and Desch were formally admitted Fellows of the Society.

The lists of names of the Officers and Council proposed for Election by the Council were read from the Chair.

Certificates were read for the first time in favour of Messrs. Henry Guest Adshead, Heysham, Wimbledon Park, Wimbledon; Harford Montgomery Atkinson, 32, Bagnall Road, Milton; George Neville Blackshaw, Agricultural College, Aspatria; Harry T. Calvert, D.Sc., West Riding of Yorkshire Rivers Board; Ben Caudwell, B.A., 28, Wigfull Road, Sheffield; Alan Fletcher, 132, Holland Road, Kensington, W.; Arthur Ernest Pitt, 66, Abbot Road, Bromley, E.; Harold Russell Pitt, 8, Church Lane, Charlton, S.E.; Frederick Robertson, The Hewan, Bearsden, Glasgow; Fitzroy Owen Jonathan Roose, Oxford Road, Bournemouth; Henry Edward Stevenson, 5, Turner's Road, Bow, London, E.; James Bates Wilkinson, M.D., Town Hall, Oldham.

Of the following papers, those marked * were read:—

*31. "*The Mechanism of the Reduction of Potassium Bichromate by Sulphurous Acid.*" By H. BASSETT, jun.

Berthier, who investigated the action of sulphur dioxide on solutions of potassium bichromate and potassium chromate (*Ann. Chim., Phys.*, 1843, [iii.], vii., 77), stated that in both cases a mixture of sulphate and dithionate was formed, but without giving details.

The reaction has now been studied more fully, and the results show that 94—95 per cent of sulphate and 5—6 per cent of dithionate are formed, when potassium bichromate, potassium chromate, or chromic acid is reduced by sulphurous acid; the amount of dithionate produced being independent of the temperature.

Solutions containing known amounts of sulphurous acid and potassium bichromate were mixed, and the excess of sulphurous acid estimated with iodine and sodium thiosulphate, or the excess of chromate determined by means of ferrous ammonium sulphate.

The freshly reduced solutions do not give the reactions of either chromium or SO_4, and seem to contain a compound—

$$\left.\begin{matrix}KSO_3\\KSO_4\end{matrix}\right\rangle Cr_2(SO_4)_2$$

(or the corresponding acid), which slowly decomposes into $Cr_2(SO_4)_3$ and K_2SO_3.

When sulphuric acid or potassium sulphate is added to these solutions, it enters into combination in such a way that the reactions of SO_4 are not given by the resulting mixture, and as many as 6 mols. of sulphuric acid may be taken up by 1 mol. of chromium sulphate.

Electrolytic experiments show that the green solutions contain a green anion, which slowly decomposes into violet chromium and SO_4 ions.

*32. "*The Constitution of Pilocarpine.*" Part IV. By H. A. D. JOWETT.

The author showed that the constitutional formula for pilocarpine, suggested by Pinner and Schwarz, is only one of several equally probable on the results hitherto recorded.

The constitution of *iso*pilocarpine has, however, been determined by a study of the reactions of dimethylglyoxaline and dimethylpyrazole and by the formation of 1-methylglyoxaline, 1 : 4(or 1 : 5)-dimethylglyoxaline, 1 : 4(or 1 : 5)-methylamylglyoxaline, and probably 1 : 4 (or 1 : 5)-methylamyleneglyoxaline, together with ammonia and methylamine, when the alkaloid is distilled with soda-lime.

Dimethylglyoxaline, from *iso*pilocarpine, boiled at 210—215° and formed crystalline salts; *platinichloride*, m. p. 238—239°; *aurichloride*, m. p. 214—215°; *picrate*, m. p. 167°. It is isomeric and not identical with the dimethylglyoxalines described in the following note. On oxidation, it yields ammonia, methylamine, and acetic acid.

Methylamylglyoxaline, from *iso*pilocarpine, boiled at 158—160° under 10 m.m. pressure; *platinichloride*, m. p. 198°; *picrate*, m. p. 134°; *aurichloride*, amorphous. On oxidation, this base yielded ammonia, methylamine, and *n*-hexoic acid.

Methylamyleneglyoxaline, which probably exists in the fraction boiling at 145—160° under 10 m.m. pressure, was not isolated; its presence was inferred from the formation of butyric acid during oxidation.

*iso*Pilocarpinolactone, on oxidation with permanganate, yielded ammonia, methylamine, and pilopic acid, whilst pilocarpine gave rise to ammonia, methylamine, and homopilopic acid.

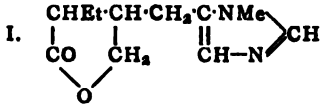
*iso*Pilocarpine, which could not be reduced electrolytically, did not form diacidic salts, and on titration behaved as a normal lactone.

*iso*Pilocarpine methiodide with picric acid, yielded the compound previously described as methyl*iso*pilocarpine picrate, but which should be termed *iso*pilocarpine methyl picrate.

The absorption spectra of pilocarpine and *iso*pilocarpine, kindly determined by Prof. J. J. Dobbie, were absolutely identical.

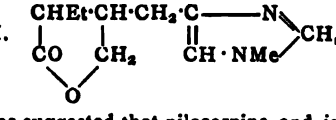
The following formulæ were proposed for pilocarpine and *iso*pilocarpine:—

I.



or—

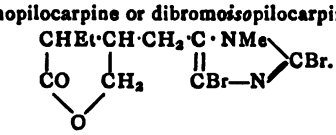
II.



and it was suggested that pilocarpine and *iso*pilocarpine are stereoisomerides, the asymmetric carbon atom involved being that contiguous to the carboxyl residue.

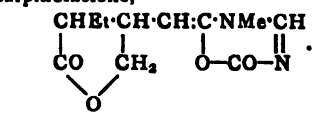
The following configurations were proposed on the basis of formula I.:—

Dibromopilocarpine or dibromo*iso*pilocarpine,—

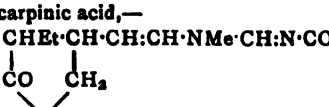


Dibromo*iso*pilocarpinic acid,—

*iso*Pilocarpinolactone,—



*iso*Pilocarpinic acid,—



Bromocarpinic acid,—

It was shown that the explanation given by Pinner and Schwarz of the formation of pilocarpoic acid, $C_{11}H_{16}O_5N_2$, is quite untenable, but no suggestions as to the constitution of this substance or pilomalic acid were offered.

*33. "*Preparation and Properties of* 1 : 4(*or* 1 : 5)-*Dimethylglyoxaline and* 1 : 3-*Dimethylpyrazole.*" By H. A. D. Jowett and C. E. Potter.

These bases were prepared in order to compare their reactions with those of *iso*pilocarpine.

1 : 4(or 1 : 5)-*Dimethylglyoxaline*, obtained from 4(or 5-methylglyoxaline (hitherto described as a liquid, but now obtained in crystals, m. p. 55°), is an oil boiling at 203°, and forming an *aurichloride*, m. p. 215°; *platinichloride*, m. p. 239°; *picrate*, m. p. 167°; *methiodide*, m. p. 156°; and *hydrochloride*, m. p. 145°. Bromine gave a crystalline *dibromo*-derivative, m. p. 127°, but at 100° under pressure the reaction was complicated, and a crystalline acid was produced. On oxidation, the base yielded ammonia, methylamine, and acetic acid, whilst by the action of potassium hydroxide the methiodide gave methylamine and acetic acid.

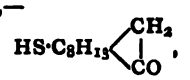
1 : 3-*Dimethylpyrazole*, prepared from 3-methylpyrazole, is a liquid boiling at 148°, which gives an *aurichloride*, m. p. 175°; *platinichloride*, m. p. 234°; *hydrochloride*, m. p. 160°; and *methiodide*, m. p. 256°. Bromine under ordinary conditions, or at 100° under pressure, gave a *dibromo*-derivative, m. p. 74°; 1-*methylpyrazole*-3-*carboxylic acid*, m. p. 222°, was obtained by oxidation of the base. The methiodide was scarcely attacked by potassium hydroxide.

Prof. C. R. Marshall states that these bases have no physiological action analogous to that of pilocarpine.

1 : 2-Dimethylglyoxaline forms a *picrate*, m. p. 179°; an *aurichloride*, m. p. 215°; a *platinichloride*, m. p. 230; and a *methiodide* which does not melt below 300°.

*34. "*Camphor-β-thiol.*" By T. M. Lowry and G. C. Donington.

Camphor-β-thiol,—



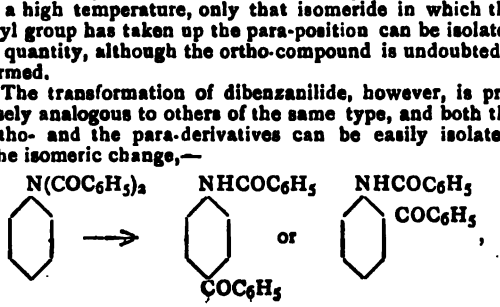
prepared by reducing the sulphochloride of Reychler's camphorsulphonic acid, is a colourless solid, of characteristic and not unpleasant odour, readily volatile with steam, which crystallises from alcohol in small, glistening prisms, and melts at 66°; $[\alpha]_D = +6°$ (in acetone). It is insoluble in alkalis, but forms a lead salt and a mercurichloride, $ClHg{\cdot}S{\cdot}C_{10}H_{15}O$. The disulphide melts at 224°; $[\alpha]_D = -90°$ (in acetone). The acetate, $AcS{\cdot}C_{10}H_{15}O$, forms needle-shaped crystals melting at 38°; $[\alpha]_D$ 8° $= -41°$ (in acetone). The benzoate, $BzS{\cdot}C_{10}H_{15}O$, melts at 59°; $[\alpha]_D$ 13° $= -16°$ (in acetone).

*35. "*Isomeric change of Dibenzanilide into Benzoyl-o-amino- and Benzoyl-p-amino-benzophenones.*" By F. D. Chattaway.

The author has previously shown (*Proc.*, 1902, xviii., 173) that acyl groups must be included among those which, under suitable circumstances, can pass from the nitrogen of an aromatic amine into the nucleus.

From the product of the isomeric change of diacetanilide at a high temperature, only that isomeride in which the acyl group has taken up the para-position can be isolated in quantity, although the ortho-compound is undoubtedly formed.

The transformation of dibenzanilide, however, is precisely analogous to others of the same type, and both the ortho- and the para-derivatives can be easily isolated. The isomeric change,—



which takes place readily under the influence of hydrogen chloride, is best effected by heating aniline (1 mol.) with benzoyl chloride (2 mols.) for eighteen to twenty hours at about 220°.

The product is hydrolysed by alcoholic hydrochloric acid, and the alcohol driven off in a current of steam. On adding water, the bases, which remain in solution as hydrochlorides, can be separated from tarry matters, and any unchanged aniline removed by making the solution alkaline with sodium hydroxide and distilling in steam. On cooling, the other bases solidify, and on dissolving the dry product in a little alcohol and adding a slight excess of strong sulphuric acid, the sparingly soluble sulphate of *p*-aminobenzophenone crystallises out. On making the mother-liquor alkaline and distilling in superheated steam, *o*-aminobenzophenone slowly distils over and crystallises from the distillate in a pure state.

About 45 grms. of *p*-aminobenzophenone and 15 grms. of *o*-aminobenzophenone can be obtained from 100 grms. of aniline.

*36. "*Formation of Purpurogallin by the Electrolytic Oxidation of Pyrogallol.*" By A. G. Perkin and F. M. Perkin.

The methods hitherto employed for the production of purpurogallin give only a poor yield, but recent experiments made by the authors on the electrolytic oxidation of pyrogallol have shown that, in general, the quantity of purified product amounts to 37—45 per cent of the calculated amount. The purified substance, which had all the properties of purpurogallin, and its acetyl derivative, gave, on analysis, figures which established its identity with this colouring matter.

The composition of the electrolytic bath has been frequently varied, and recently a solution containing 28 grms. of pyrogallol, 10 c.c. N-sulphuric acid solution, and 50 grms. of sodium sulphate in 500 c.c. of water has been found to be most effective. The best results have been obtained by using a rapidly rotating anode of platinum-iridium and a cathode of lead or graphite. The current density was 4—6 ampères with an E.M.F. of 8—10 volts, The behaviour of other phenolic substances under similar conditions is now under investigation. Gallic acid yields a small quantity of a product which probably contains the purpurogallincarboxylic acid recently described (*Trans.*, 1903, lxxxiii., 199).

37. "*The Analysis of* Reh, *the Alkaline Salts in Indian* usar *Land.*" By E. G. Hill.

The upland barren lands of India, extending over an area of about two million acres, which are mainly found betweed the Jumna and the Ganges, and also between the latter and the Gogra, contain so large a quantity of soluble salts in the soil that agriculture is practically impossible. The reclamation of this land has occupied the attention of the Government of India for many years, but less effort has been made to utilise the soluble salts. Such lands have the following general features:—The soil is impermeable for a varying depth below the first few inches; below the impermeable layer is a coarser layer, more or less porous, in which nodular limestone is generally found, and this is sometimes so thick and continuous as practically to form a rock. The upper soil is thus shallow and fitted for the concentration of soluble salts. Such land varies in appearance according to its humidity and the amount of salts which it contains. Efflorescence is frequent, and a grey colour is general. An account of the various attempts which have been made to utilise *usar* land has been published in the "Indian Agricultural Ledger" (1901, No. 13) by W. H. Moreland, but analyses of the soluble salts contained in these soils have not been recorded, and no attempts have been made to extract these substances and employ them on a large scale. Out of the samples analysed, none contained less than 88 or 89 per cent of sodium carbonate, but the percentage of salt in the soil varies very materially according to the district and the sub-soil. In the districts where

there is a considerable quantity of alkali in the soil, the upper layers are collected and sold under the name of *sujji muttee*. This is used by native washermen in place of soap, and in Allahabad one tradesman makes a crude soap by boiling the solution of this earth with lime and castor oil.

Glass has also been made from this sodium carbonate, the chief product being the glass bangles which are so common in the country; sodium hydroxide has also repaid its manufacture, especially in the vicinity of paper mills. Both sodium carbonate and sodium hydroxide are, however, largely imported into India; the former, especially, being employed in the aëration of mineral waters.

It was thought that *reh* might be interesting from a chemical point of view, and it was examined in order to ascertain whether any sodium sesquicarbonate was present, since this substance occurs in other parts of the world as the native carbonates, *trona* and *urao*.

Each sample of earth was digested with hot water several times, and the solution filtered. In each case, the light brown solution thus obtained yielded on evaporation large and well-defined crystals of the decahydrated normal carbonate, but fractional crystallisation gave a few monoclinic crystals imbedded in the solid mass produced by slowly evaporating the third fraction. These became opaque on being scratched, and were possibly efflorescent.

The solution, which contained a considerable amount of humus, was evaporated to dryness on the water-bath, the residue being freely powdered and dried in a steam oven until the weight was constant. This was a long and tedious process; the weight diminished steadily for forty-eight hours, although less than half a grm. of the substance was taken. There is therefore probably some hydrogen carbonate in the soluble salts. When the weight was constant, a combustion was made with the following result:—

0·3892 grm. gave 0·0278 CO_2 and 0·0078 H_2O with a residue of 0·3584 Na_2CO_3.

The loss in the dried sample was thus 0·0308 grm. or approximately 8 per cent, a result which was confirmed by igniting other portions of the dried salt in a weighed crucible.

Assuming that humus is half the weight of the CO_2 derived from it, and that the difference between the gain in the absorption tubes and loss in the combustion boat is due to oxidation of humus, we get 0·0048 grm. of humus or 0·0096 grm. of CO_2 due to humus. This leaves 0·0182 grm. of CO_2 due to the decomposition of sesquicarbonate at red heat.

The corresponding quantity of sesquicarbonate is 0·1133, which would yield 0·0075 grm. of water. The water found was 0·0078 grm. Hence the dried salt contained 29·9 per cent of sesquicarbonate. The above experiments were made with the Pertabgarh sample.

The soluble salts in five samples from different districts were analysed with the results shown in the Table (Section A.).

There were slight traces of silica and lime in each sample. These analyses indicate that the five samples have the percentage compositions shown in Section B.

	District.				
	Pertabgarh.	Benares.	Mirzapur.	Allahabad, trans-Ganges.	Allahabad, trans-Jumna.
	Percentage of soluble salts.				
	6·3.	3·1.	16·6.	6·3.	6·5.
			A.		
Na_2O ..	57·70	57·72	56·70	57·60	57·61
CO_2 ..	39·72	39·40	36·97	39·17	39·33
Al_2O_3 ..	0·31	0·12	0·12	trace	trace
SO_3 ..	—	—	5·26	2·32	1·71
Cl	2·06	2·67	0·73	0·77	1·06
P_2O_5 ..	0·56	0·45	0·38	0·35	0·64
	100·35	100·36	100·16	100·21	100·37
			B.		
Na_2CO_3 .	95·63	95·08	88·90	94·38	94·80
NaCl ..	3·39	4·40	1·20	1·21	1·75
Na_2SO_4 .	—	—	9·34	4·12	3·02
P_2O_5 } ..	As above.				
Al_2O_3 }					

38. "*Experiments on the Synthesis of Camphoric Acid.* Part III. *Synthesis of Isolauronolic Acid.*" By W. H. Perkin, jun., and J. F. Thorpe.

When ethyl cyanodimethylsuccinate,—

$$CO_2Et\cdot CMe_2\cdot CH(CN)\cdot CO_2Et,$$

prepared by treating the sodium compound of ethyl cyanoacetate with ethyl bromo*iso*butyrate, is digested with sodium ethoxide and ethyl β-iodopropionate in alcoholic solution, *ethyl cyanodimethylbutanetricarboxylate*,—

$$CO_2Et\cdot C(CN)\begin{matrix}CH_2\cdot CH_2\cdot CO_2Et\\ CMe_2\text{——}CO_2Et\end{matrix},$$

is obtained as an oil which distils at 210—215° under 13 m.m. pressure.

On hydrolysis with dilute sulphuric acid, this ester is converted into *dimethylbutanetricarboxylic acid*,—

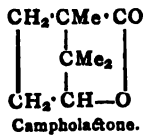
$$CO_2H\cdot CH\begin{matrix}CH_2\cdot CH_2\cdot CO_2H\ (a)\\ CMe_2\text{——}CO_2H\ (b)\end{matrix},$$

a colourless, crystalline substance which melts at 155—157°.

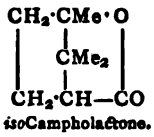
When the trisodium salt of this acid is digested with acetic anhydride, carbon dioxide and water are eliminated between the two carboxyl groups (*a*) and (*b*), and *ketodimethylpentamethylenecarboxylic acid*,—

$$CO_2H\cdot CH\begin{matrix}CH_2\text{—}CH_2\\ |\quad\ |\\ CMe_2\cdot CO\end{matrix},$$

is formed. This acid crystallises well, melts at 110°, yields an ethyl ester distilling at 172° (100 m.m.), and a semicarbazone melting at 217°. The ethyl ester, when treated with magnesium methyl iodide in ethereal solution, is converted into a lactone which distils at 155—157° (50 m.m.), and has a most penetrating odour of peppermint. This new lactone, for which the name *isocamphololactone* is proposed, is isomeric with campholactone, and the close relationship which exists between these two substances is obvious when their formulæ are written side by side:—



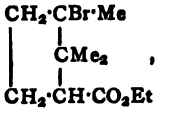
Campholactone.



*iso*Campholactone.

The above formation of *iso*campholactone constitutes the first synthesis of that trimethylpentamethylene ring which is the basis of camphoric acid and of so many other substances belonging to the camphor group, and it is hoped that it may ultimately be possible to obtain camphoric acid itself from this lactone.

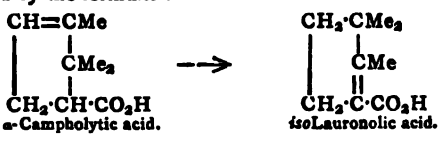
When the lactone is treated with phosphorus pentabromide and the product poured into alcohol, ethyl bromotrimethylpentamethylenecarboxylate is formed:—



and is an oil which distils at 165°—170° under 70 m.m. pressure.

In an experiment in which this bromo-ester was heated with potassium cyanide in alcoholic solution, and then

with alcoholic potash, a quantity of an oily acid was obtained which was obviously inactive *a*-campholytic acid, produced from the bromo-ester by elimination of hydrogen bromide and subsequent hydrolysis. This was proved by the fact that, on distillation with dilute sulphuric acid, the oil was converted into a crystalline acid melting at 132°, which, on examination, was easily identified as *isolauronolic acid*, the well-known isomeric change indicated by the formulæ :—



a-Campholytic acid. *iso*Lauronolic acid.

having taken place,

That the *iso*lauronolic acid, thus synthesised, is identical with *iso*lauronolic acid obtained from camphoric acid was shown by mixing equal quantities of the two preparations, when the mixture melted at 132°, the melting-point of the constituents. Furthermore, the synethetical acid, on oxidation with permanganate, yielded *iso*lauronic acid.

(To be continued).

NOTICES OF BOOKS.

Report on the Agricultural Work in the Botanic Gardens and Government Laboratory for the Years 1896-1901, *at Georgetown, Demerara.* By J. B. Harrison, Government Analyst. Printed by the Authority of His Excellency the Governor. Georgetown : C. K. Jardine. 1902. Pp. 136.

The report now before us is somewhat belated, but this is explained by the failing health and subsequent death of Mr. G. S. Jenman, who for some years past has collaborated with Mr. Harrison.

The report has been divided into two parts. Part I. deals with the meteorology of the period under review, with the experiments carried on with varieties of sugar-canes, especially with the production of new varieties from seed, and with the manurial experiments; and Part II., on various other subjects of agricultural interest which have occupied the attention of the two departments during recent years.

Perhaps the most valuable portion of the report is to be found in Chapter IV. on Manurial Experiments. Some of the conclusions arrived at as a result of these experiments are both interesting and valuable, especially as they are formed on experiments lasting over eleven years.

It is found that nitrogen is an essential constituent of sugar-cane manures, as in each crop the manurings with nitrogen gave greatly increased yields, 40 lbs. of nitrogen in the form of either sulphate of ammonia or nitrate of soda having yielded, on the average, 6·9 tons of produce, which could yield 0·56 ton of first and second sugars per acre. In other words, 10 lbs. of nitrogen, on land not limed, is equivalent to 1·6 tons of canes, or nearly 3 cwts. of sugar.

The West Indies and British Guiana have had a hard struggle for many years, but they have tackled the problem of making sugar-growing profitable in a plucky manner, and we trust that now, aided by Legislative measures concerning Sugar Bounties, they are on the eve of another era of prosperity, such as they enjoyed in olden times, before beetroot sugar became so dangerous a competitor.

The Figures, Facts, and Formulæ of Photography, and Guide to their Practical Use. Edited by H. Snowden Ward. London: Dawbarn and Ward, Ltd. 1903. Pp. 166.

This volume will no doubt be of use to photographers, containing as it does a large amount of information in a condensed form. It is divided into thirty-three sections, and there can be no complaint that it does not begin at the beginning.

The first paragraph in Section I., on the Studio, is on how to make fabrics and materials fireproof; the author, however, does not recommend the use of tungstate of soda, a salt we have found to be efficacious. In a subject so wide as photography the difficulty is to keep the volume of facts within reasonable limits; the endeavour here has been to include only all that is necessary for practical working, while there are also a few sections on what may be called allied subjects, such as the law of copyright, toilet and hygiene, poisons and their antidotes, &c.

CORRESPONDENCE.

PATENT LAW IN THE UNITED STATES.

To the Editor of the Chemical News.

Sir.—We have received information of important changes in the United States Patent Law to the effect that the Senate on the 3rd inst. passed a Bill (No. 17085) to give effect to the provisions of the International Convention, the Bill having previously passed the House of Representatives. The Bill was signed by the President on the 4th inst., and now has the force of law.

The Bill provides for giving priority to applications filed under the International Convention, and also provides, in respect to applications filed otherwise than under the Convention, that they shall not be refused by reason of the invention being previously patented abroad, unless the application for the foreign patent was filed more than *twelve* months before the application in this country. The fourth section of the Bill extends the right of filing Caveats to foreigners; so that, as the law now stands, any person, whether a citizen of the united states or foreigner, may file a Caveat. The second section of the Bill amends Section 4892 of Revised Statutes, to the extent that oath may now be taken before any Notary Public, Judge, or Magistrate having Official Seal and authorised to administer Oaths in the foreign country in which the applicant may be. This section of the Bill, however, requires that in case of oath taken before a foreign Notary, Judge, or Magistrate, must be legalised. The third section of the Bill amends Section 4896 of Revised Statutes, so that a foreign-appointed Executor may apply for patent in this country without being required to take out ancillary letters of administration in this country.

The importance of this amendment in the American Patent Law has very far-reaching effects, and will no doubt be of interest to your readers,—We are, &c.,

J. E. Evans-Jackson & Co.

Bristol House,
19 & 20, Holborn Viaduct, London, E.C.,
March 17th, 1903.

The Chemical Laboratory at Wiesbaden.—During the Winter Term, 1902-03, the Chemical Laboratory Fresenius was attended by thirty-seven Students. Of these, twenty-eight were from Germany, two from Russia, one from Austria, one from Switzerland, one from Italy, one from England, one from Sweden, one from Spain, and one from the Transvaal. There were three Assistants in the Instruction-Laboratory, and twenty-four in the Versuchsstationen (private laboratories). To the body of teachers belong the Directors, Prof. Dr. H. Fresenius, Prof. Dr. W. Fresenius, Prof. Dr. E. Hintz, and also Prof. Dr. Med. G. Frank, Dr. L. Grünhut, and J. Huber (Architect). The next Summer Term begins on April 24th. During the Winter Term, 1902-03, besides the scientific researches, a great number of analyses were undertaken in the different departments of the Laboratory (Versuchsstationen), on behalf of trade, manufacture, mining, agriculture, and hygiene.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

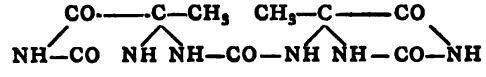
Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 8, February 23, 1903.

Law of Electromotive Forces of Saline Solutions. Influence of Temperature.—M. Berthelot.—The relation between the electromotive forces of saline solutions has been previously found by the author. He now further examines the subject to find how the law depends on temperature and concentration. He therefore places the elements of the pile in an Arsonval stove, which can be kept at fixed temperatures, and examines in turn cells containing hydrochloric acid and soda, nitric acid and soda, sulphuric acid and soda, boric acid and soda, acetic acid and soda, and finally formic acid and soda. An absolute relation was not determined between the temperature and the electromotive force.

The Influence of certain Treatments on the Micro-structure of Nickel Steels.—Léon Guillet.—The author examines the micro-structure of nickel steels when subjected to the following treatments:—Tempering, heating, strain, chilling, cementation, and decarburation. His results point to the fact that a micro-examination of the surface of steel is much more sensitive than either mechanical or magnetic tests to the transformations undergone by nickel steels by the various treatments.

Certain Products of the Reduction of Copper Salts by Hydroxylamine.—E. Pêchard.—The reduction of copper in ammoniacal solution by hydroxylamine serves as the starting point for the preparation of a number of new cuprous salts, such as cuprous acetate and ammoniacal cuprous sulphate.

Action of Urea on Pyruvic Acid. (II.). Dipyruvic Triuride.—L. J. Simon.—The author examines the action of concentrated hydrochloric acid on homoallantoïne, the second product of the action of urea on pyruvic acid. Dipyruvic triuride is thus obtained, which has already been isolated by Grimaux, and has the formula—



The body thus obtained is white and crystalline in fine needles. It is insoluble in organic solvents, very slightly soluble in water, but soluble in alkalis and concentrated mineral acids. Its composition is represented by the formula $C_9H_{12}N_6O_5.2H_2O$. The author examines the action of heat, hydrochloric acid, water, alkalis, and ammoniacal silver nitrate on this body.

Certain Phosphorus Acids derived from Benzophenone and Methylpropylketone.—C. Marie.—The author examines the acids obtained from the action of H_3PO_2 on benzophenone and methylpropylketone and the oxyphosphinic acids which are formed by their oxidation.

Bulletin de la Société Chimique de Paris. Series 3, Vol. xxvii., No. 18—19.

On Perchloric and Periodic Acids.—A. Astruc and H. Murco.—Already inserted in full.

The Complex Salts of Platinum. Reactions of the Plato-oxalonitrites.—M. Vèzes.—Already inserted in full.

Two New Sugars obtained from Manna, Manneotetrose, and Manninotriose. The Composition of Manna.—C. Tanret.—Manna, used by pharmaceutical chemists, is a sugary exudation from the ash-tree, *Fraxinus ornas* and *F. rotundifolia*, cultivated in Southern Europe. The author describes the method used for the extraction of the two sugars, manneotetrose and manninotriose, as well as their composition, properties, and general characteristics. Anhydrous manneotetrose has the formula $C_{24}H_{42}O_{21}$, it crystallises in water with $4{\cdot}5H_2O$, and in alcohol at 90° with $4H_2O$. The hydrolysis of manneotetrose by means of dilute mineral acids shows it to be a tetrose; 1 molecule of manneotetrose is transformed by the fixation of water into 4 molecules of monoses; that is, 2 of galactose, 1 of glucose, and 1 of levulose, according to the equation $C_{24}H_{42}O_{21} + 3H_2O = 4(C_6H_{12}O_6)$. Manninotriose has the formula $C_{18}H_{32}O_{16}$. When hydrolysed by dilute mineral acids it splits up into 2 molecules of galactose and 1 of glucose, and is thus undoubtedly a triose. The author found two samples of manna to have the following compositions:—

	Per cent.	Per cent.
Mannite	40	55
Water	10	10
Glucose	3·0	2·2
Levulose	3·4	2·5
Manneotetrose ..	16·0	12·0
Manninotriose ..	16·0	6·0
Salts	2·0	1·5
Resin	0·1	0·05
Undetermined ..	the remainder	

The Solubility of Prussian Blue.—G. Wyrouboff.—A criticism of M. Coffignier's paper on the same subject in the *Bull. Soc. Chim.*, Series 3, vol. xxvii., p. 696.

The Double Nitrites of Iridium.—E. Leidié.—Already noticed.

New Method for the Purification of Potable Waters.—P. Guichard.—Already inserted.

A New Di-iodised Phenol.—P. Brenans.—Already noticed.

Some Organic Compounds of Addition.—M. Lemoult.—The author finds that the polynitrated benzenic derivatives having 1 atom of chlorine, or an HO group, or an NH_2 group, unite with the greatest facility with the substituted *p*-diamised derivatives of diphenylmethane, giving well crystallised compounds of addition, resulting from the juxtaposition of the 2 molecules used, and easily decomposed into their constituents.

Some Derivatives of β-Naphthylamine.—A. Reychler.—The author gives some details concerning the preparation and properties of methylethyl-β-naphthylamine. When we enclose in a sealed tube an equimolecular mixture of ethyl-β-naphthylamine and iodide of methyl and a small quantity of methylic alcohol, we observe that a reaction commences immediately with a marked rise of temperature. After heating to 100° for a quarter of an hour the contents of the tube are cooled, poured into water, and decomposed by the addition of caustic soda; this gives a mixture of insoluble products, which may be collected in a supernatant layer of benzene. The aqueous layer contains not only an alkaline iodide and some soda, but a considerable amount of a quaternary iodide of ammonium, which separates in the cold in the form of an oily deposit, and even crystallises eventually. The benzenic layer is purified by several washings with warm water; it contains methylethyl-β-naphthylamine and unchanged ethyl-β-naphthylamine, which are separated by drying and concentrating the benzenic solution and heating the residue with an excess of acetic anhydride. After heating for an hour to about 90° or 100°, the whole is poured into dilute hydrochloric acid, and two solutions are obtained; (1) a benzenic solution of acetylised ethylnaphthylamine, and (2) an acid aqueous solution of methylethylnaphthylamine.

The Analysis of Lithopone.—Ch. Coffignier.—Already inserted.

The Stereo-chemistry of Nitrogen.—A. Reychler.—Not suitable for abstraction.

The Stereo-chemistry of Nitrogen and the Rotatory Power of *d*-Camphorsulphonate of Methylethyl-β-naphthylamine.—A. Reychler.—I. Solutions were made in a mixture of about 9 parts of acetic ether and 1 part of absolute alcohol. The temperature of the determinations (*d* and *a*) was 20°. Concentration of the solutions, *p* = 7 to 8 per cent.

d-Camphorsulphonate of dimethyl-β-naphthylamine $[\alpha]_D$	= +35°
d-Camphorsulphonate of methylethyl-β-naphthylamine—First fraction	+32°
Second fraction.. ..	+32·1°
d-Camphorsulphonate of diethyl-β-naphthylamine	+27°

II. Alcoholic solutions. Temperature = 20, *p* = about 7 per cent.

d-Camphorsulphonate of dimethyl-β-naphthylamine $[\alpha]_D$	= +30°
d-Camphorsulphonate of methyethyl-β-naphthylamine—First and second fractions	+28°
d-Camphorsulphonate of diethyl-β-naphthylamine	+26·5°

Action of Tetrazoic Chlorides on Oxalacetate of Ethyl.—J. Rabischong.—A tenth of a molecule or 18·4 grms. of benzidine is dissolved in 50 c.c. of hot hydrochloric acid at 40 per cent and 250 c.c. of water. The solution, cooled down to 0° with ice, is treated with a solution of nitrite of soda at 13·8 per cent. The tetrazoic chloride obtained is then treated with 90 grms. of acetate of soda dissolved in 200 c.c. of water. The filtered solution is poured gradually into 37·6 grms. of oxalacetic ether dissolved in 300 c.c. of alcohol kept at 0°. Immediately a deep red mass separates, which, after washing and drying, is easily soluble in xylol. Supersaturated hot solutions deposit small carmine-red crystals on cooling; they consist of diphenyldihydrazone-oxalacetate of ethyl. The author describes several other bodies obtained in a similar manner.

The Rotatory Power of Hydrochlorate of Cocain.—M. Imbert.—The rotatory power of hydrochlorate of cocain in water and alcohol at 40° diminishes as the concentration is augmented. It becomes constant at −67° 50′, in alcohols at 65° to 80°. The constant value $[\alpha]_D$ is exactly that given by a 10 per cent aqueous solution and a solution of alcohol at 40° containing 6 per cent of salt.

Essence of Badiane from Japan.—E. Tardy.—By fractional distillation, which, however, does not give very satisfactory results, two groups of substances are obtained, one from 150° to 180°, and the other from 220° to 280°; the author describes various experiments and treatments of these two portions.

Essence of Badiane from China.—E. Tardy.—This essence is very different from the Japanese essence, and can be divided by fractional distillation into many more portions, at least two dozen, from that coming over below 150° to that coming over at 230—235°. It contains pinene, phellandrene, estragol, dextrogyre terpilenol, anethol, a levogyre sesquiterpene, anisic aldehyd, anisic acetone, anisic acid, a small quantity of a crystallised body with the formula $C_{20}H_{22}O_3$, and an equally small quantity of ethylic ether of hydroquinone.

Essence of Bitter Fennel.—E. Tardy.—The author gives the analysis and properties of essence of bitter fennel from Algiers and one from Galicia. The quantities of hydrococarbons and that of estragol are greater in the Algerian essence than in that from Galicia. It is the effect of the influence of climate.

Examination of "Civet."—A. Hébert.—Besides the specific differences found to exist in the secretions from different individuals, the author finds that in commercial samples the composition of "civet" is further influenced by the method of extraction adopted.

The Estimation of Alcohol in very Dilute Solutions.—G. Argenson.—Already inserted in full.

Action of Blood on Peroxide of Hydrogen.—J. Ville and J. Moitessier.—Blood decomposes peroxide of hydrogen with an energy which varies according to the species of the animal used, but it is indispensable to take note of the acidity of the peroxide used, or the results will vary considerably. The authors have also examined the effect of the influence of the quantity of peroxide used; that of the dilution of the blood, and the dilution of the peroxide, and they find that the acidity and the dilution of the peroxide have the greatest effect on its action.

MISCELLANEOUS.

Photographic.—Messrs. Welcome and Co. have published a small Exposure Record and Diary, in pocket-book form, full of information useful to the photographer. The Diary, printed on tough thin paper, includes a light table for each month; and there is an ingenious exposure calculator at the end of the book.

Institute of Chemistry of Great Britain and Ireland.—The next Examinations of the Institute of Chemistry, for persons desirous of qualifying themselves to be public and technical analysts, will be held in July, 1903. The Examinations are open only to candidates who have complied with the Regulations. The Intermediate Examination will be held at 30, Bloomsbury Square, London, W.C., and at the Glasgow and West of Scotland Technical College, George Street, Glasgow, commencing on Tuesday, July 7th. Examinations in the following branches of the Final Examination for the Associateship (A.I.C.) will be held in London, and may commence on either July 7th or 14th:—(*a*) Mineral Chemistry, (*b*) Metallurgical Chemistry, (*c*) Physical Chemistry, (*d*) Organic Chemistry, and (*e*) The Analysis of Food and Drugs, and of Water, including an Examination in Therapeutics, Pharmacology, and Microscopy. The Final Examination in the branch of Biological Chemistry will be held in October.

The Solution of Molecular Combinations.—G. Bodlaender and R. Fittig.—The solubility of an insoluble salt in the solution of a body capable of forming a molecular combination with it, does not give any precise indications. Thus it is that the study of the solutions of chloride of silver in ammonia gives results which only agree very indifferently with the formulæ, $AgCl(NH_3)_2$, $(AgCl)_2(NH_3)_3$, $(AgCl)_3(NH_3)_4$, and $(AgCl)_m(NH_3)_{m+1}$. To recognise the value of *m*, it is necessary to examine the solubility of AgCl in solutions containing, besides ammonia, chlorides or nitrate of silver. In both cases the solubility of the AgCl is diminished; its variation with the contents of the solution in chlorine or in silver gives for the dissolved complex salt the formula $AgCl(NH_3)_2$. Bromide of silver gives a compound with a similar formula. Both chloride and bromide of silver are insoluble in solutions containing only 2 molecules of NH_3 per molecule of AgCl or AgBr; an excess of ammonia is necessary to prevent the dissociation of the complex ion. On the other hand, the soluble salts of silver only require an amount of NH_3 hardly greater than 2 molecules, in order to give the complex salt. The constant of dissociation of the complex ion, $Ag(NH_3)_2$, into Ag and $2NH_3$ can be deduced, not only from the measurements of solubility, but also from the measurements of the electromotive force; its value is:— $k = \frac{Ag + 2NH_3}{Ag(NH_3)_2} = 6{\cdot}8 \cdot 10^{-8}$. The free energy corresponding to this transformation into normal solution is 9832 calories.—*Zeit. Physik. Ch.*, vol. xxxix., p. 597.

MEETINGS FOR THE WEEK.

MONDAY, 23rd.—Society of Arts, 8. (Cantor Lectures). "Hertzian Wave Telegraphy in Theory and Practice," by Prof. J. A. Fleming, M.A., D.Sc., F.R.S.

TUESDAY, 24th.—Royal Institution, 5. "Great Problems in Astronomy," by Sir Robert Ball, F.R.S.

WEDNESDAY, 25th.—Society of Arts, 8. "Oil Light by Incandescence," by Arthur Kitson.

THURSDAY, 26th.—Royal Institution, 5. "Society during the Commonwealth and Protectorate," by Charles Harding Firth, M.A.

FRIDAY, 27th.—Royal Institution, 9. "The Pearl Fisheries of Ceylon," by Prof. W. A. Herdman, D.Sc., F.R.S.

SATURDAY, 28th.—Royal Institution, 3. "Light—its Origin and Nature," by Lord Rayleigh, F.R.S., &c.

CITY OF BIRMINGHAM.

MUNICIPAL TECHNICAL SCHOOL.

The Corporation require, in September next, the services of a HEAD of the CHEMISTRY DEPARTMENT, which post will be then vacant owing to the retirement of Mr C. J. Woodward under the Superannuation Scheme. The commencing salary offered is £300 per annum.

The last date for sending in applications is APRIL 8th.

Personal canvassing of members of the Committee by applicants or their friends will be a disqualification.

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LECTURES.

Experimental Chemistry (Inorganic)	Prof. H. FRESENIUS, Ph.D.
Experimental Physics	Prof.W.FRESENIUS, Ph.D.
Stöchiometry	
Organic Chemistry	L. GRÜNHUT, Ph.D.
Chemical Technology	
Microscopy, with exercises in Microscopic work	W. LENZ, Ph.D.
Chemistry and Analysis of Foods ..	Prof.H. FRESENIUS, Ph.D. Prof.W.FRESENIUS, Ph.D., and Prof. E. HINTZ, Ph.D.
Hygiene	Prof. Dr. med. G. FRANK.
Practical exercises in Bacteriology ..	
Technical Drawing, with exercises ..	J. HUBER.

The next Session commences on the 24th of April. The Regulations of the Laboratory and the Syllabus of Lectures will be forwarded gratis on application to C. W. KREIDEL'S Verlag, at Wiesbaden, or to one of the Directors.

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Re Pirie *v.* The Electro-Chemical Co. (1900), Ltd., 1901, E. 85.—By order of Mr. Justice Farwell.—Mr. F. J. Terry Horsey, of the firm of—

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ST. PAUL'S SCHOOL, West Kensington.—An EXAMINATION will be held at the above School on Tuesday, April 21st, 1903, and the following days, for filling up Five or more Vacancies on the Foundation.—Full particulars can be obtained on application to the Bursar.

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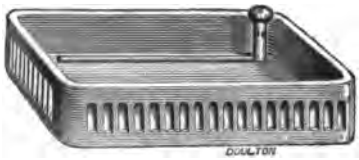

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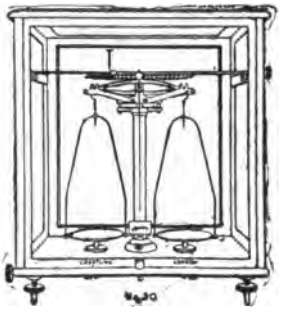

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THE CHEMICAL NEWS.

VOL. LXXXVII., No. 2261.

THE POSITION OF RADIUM IN THE PERIODIC SYSTEM AS INDICATED BY ITS SPECTRUM.

By C. RUNGE and J. PRECHT.

THE spark spectrum of radium may be readily observed by using the radium bromide recently prepared by Prof. Giesel. A few milligrms., which Prof. Giesel kindly placed at our disposal for this purpose, were sufficient to enable us to obtain with smaller dispersion a more complete spectrum than had as yet been observed, and with greater dispersion to investigate with regard to their behaviour in the magnetic field the lines which may be easily photographed. We have thus found that the strongest radium lines are completely analogous to the strongest barium lines and to the corresponding lines of the allied elements Mg, Ca, Sr. These may be grouped, as Runge and Paschen have shown (*Ber. d. Berl. Akademie*, June 26, 1902), as three pairs of lines, which, on account of certain analogies with the spectra of the alkalis, they denote as the pair of lines of the principal series, and the pairs of lines of the first and second secondary series. With the pair of lines of the first secondary series close to the line of greater wave-length a fainter line, which Runge and Paschen call a satellite, appears on the side of the greater wave-lengths. Measured on the scale of the oscillation numbers both lines of each of these three pairs have the same distance for each element, only in the pair of the first secondary series instead of the one line the satellite must be taken. For different elements the distance, on the other hand, is different, and it increases with increasing atomic weight in a perfectly uniform manner, as will be further discussed below. In the magnetic field, as Runge and Paschen have shown, these lines split up in various ways into components, in such a manner, however, that, measured on the scale of the oscillation numbers, the splitting up of each line of one element is exactly the same as that of the corresponding line of each of the other elements.

We have now found that the same holds good for radium, so that radium must be placed in a group of chemically allied elements with Mg, Ca, Sr, Ba, as its chemical behaviour (so far as it is known at present) also demands.

In the following table the lines which correspond to one another are placed together:—

	Mg.	Ca.	Sr.	Ba.	Ra.
Principal series ..	2803	3969	4216	4934	4682
	2796	3934	4078	4554	3815
1. Secondary series	—	3181	3475	4166	4436
	2798	3179	3465	4131	4341
	2791	3159	3381	3892	3650
2. Secondary series	2937	3737	4306	4900	5814
	2929	3706	4162	4525	4533

The splitting up of the radium lines in the magnetic field may be very readily observed in the strongest lines. Up to the present we have succeeded in splitting up all the lines except the satellite and the line 5814 in the yellow.

The differences between the two lines of the pairs are, as was mentioned above, the same for each element, when measured on the scale of the oscillation numbers. The same holds good for radium, as the following table shows:—

	λ.	10⁸/λ.	Difference.
Principal series ..	4682·35	21356·8	4858·3
	3814·59	26215·1	
1. Secondary series ..	4436·45	22540·5	4858 5
	3649·77	27399·0	
2. Secondary series ..	5813·9	17200 2	4858·6
	4533·33	22058 8	

The variations of the three differences from one another are adequately explained by errors of observation. They correspond to very small errors in the wave-length determinations.

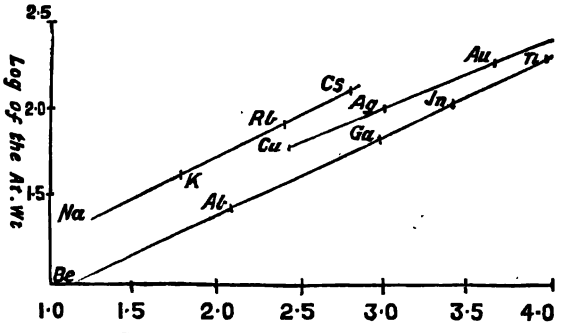


FIG. 1.—Log. of the difference of lines (0·01 scale divisions = 2·3 per cent of the value).

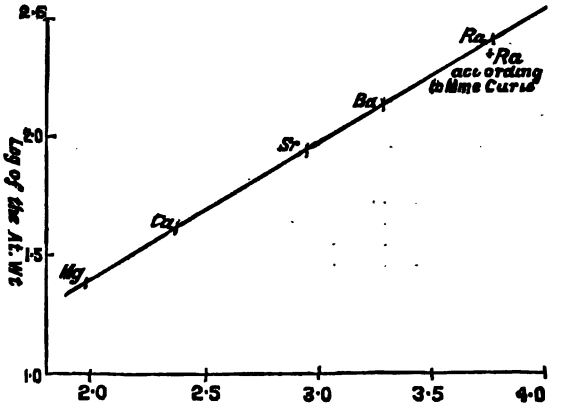


FIG. 2.—Log. of the difference of lines (0·01 scale divisions = 2·3 per cent).

In the case of Mg, Ca, Sr, Ba the differences increase with the atomic weight of the elements.

	Atomic weight.	Difference.
Mg	24·36	91·7
Ca	40·1	223
Sr	87·6	801
Ba	137·4	1691

Hence the atomic weight may be regarded as a function of the difference, and this function may be obtained for radium by extrapolation. In the reports of their researches on the spectra of the elements, Rydberg and Kayser and Runge have already alluded to the fact that the differences of the pairs of lines in a group of chemically allied elements increase regularly with the atomic weight. In the case of the alkalis they state that the atomic weight is very nearly proportional to the square root of the difference. We might mention in regard to this that for the other groups in which pairs of lines have been observed, the relation between the difference of the pairs of lines and the atomic weight may be simply expressed:—

In every group of chemically allied elements the atomic weight is proportional to a power of the difference of the two lines of the pair of lines.

The exponent is a proper fraction. Or otherwise expressed:—

If the logarithms of the atomic weight and difference are taken as co-ordinates, the points corresponding to a group of chemically allied elements lie on a straight line.

In the two accompanying figures this law is illustrated.

In Fig. 1 we see that in the case of the alkalis, only potassium lies somewhat beneath the straight line passing through the other points. We do not wish to say that therefore the atomic weight of potassium as obtained by stochiometric methods is incorrect, but it appears to us interesting that the deviation from the law of the straight line is greater in the case of the identical element whose atomic weight in the periodic system points to some unknown disturbing circumstance, causing the inverted position of argon and potassium.

As regards boron, gallium, and indium, the radiation in the magnetic field in these elements has not been investigated. Nevertheless, there can be no doubt about the pairs of lines, which correspond to those of aluminium and thallium. The same holds good for the alkali group in which only the two yellow sodium lines have been investigated in the magnetic field.

In Fig. 2 the same relation is shown for Mg, Ca, Sr, Ba, Ra. Extrapolation gives the value 258 for the atomic weight of radium. Naturally the straight line may be somewhat turned or moved out of its place without deviating too far from the points, but the figure shows clearly that the value 225 obtained by Mdme. Curie is at some distance from the straight line.

In the following table the straight line is replaced by a formula, and extrapolation by calculation.

If x denotes the difference of the pair of lines, measured on the scale of the oscillation numbers $10^{5}/\lambda$, then we have:—

$$\text{At. wt.} = \text{num. log}\,(0{\cdot}2005 + 0{\cdot}5997 \log x).$$

	Formula.	Observed at. wt.
Mg..	23 84	24·36
Ca	40 6	40·1
Sr	87·5	87·6
Ba	136·9	137·4

Extrapolation gives for radium the calculated atomic weight of radium 257·8.

We do not venture to assert that our number is more accurate than the value obtained by Mdme. Curie. Nevertheless, it may be mentioned that owing to the close relationship between barium and radium, and owing to the small quantities of the substance with which the chemist is forced to work, the complete separation of these two substances is very difficult, and Mdme. Curie must have found too low an atomic weight in consequence of incomplete separation. According to the crystallographic observations of F. Rinne, which will shortly be made public, radium bromide and barium bromide are isomorphous with one another, so that a simultaneous crystallisation of the two substances (isomorphous mixture) is *à priori* very probable, supposing that the solubility ratios are similar. Hence the great difficulty in separating the two substances from one another by crystallisation, so that even after constantly repeated crystallisation more or less barium may still be present in the corresponding radium compound. The same holds good for the relation of radium to calcium, as well as to strontium and magnesium.

The number 225 agrees better with the periodic system, inasmuch as it fits into the gap between bismuth and thorium in the right column. If the atomic weight is 258, radium must move two series further in the column Mg, Ca, Sr, Ba, and a number of new unoccupied places arise in the periodic system.

On the other hand, we may bring forward in favour of the greater atomic weight what Rutherford has observed. The greater atomic weight suggests a complicated structure of the atom, and hence a greater tendency for the formation of electrons. The element which forms electrons most readily should thus have also the greatest atomic weight.

The radium line, 4826·14, which appears in the Bunsen flame more distinctly than all the other lines, is also, after being split up in the magnetic field, analogous to the strongest Bunsen flame lines: Ba, 5535; Sr, 4607; Ca, 4226. All these lines may be split up into three components, which in all these elements, when measured on the scale of the oscillation numbers, are at equal distances from one another.—*Physikal. Zeit.*, iv., 285.

A NEW REACTION FOR THE FATTY ACIDS.

By Dr. HANS KREIS.

Bellier proposed the following reaction for the detection of olive oil:—Mix and shake up the oil with an equal volume of a saturated solution of resorcin in benzol and the same amount of nitric acid (density = 1·38) free from nitrous acid.

If the olive oil is pure no colouration is produced, or at most a very slight change is observed; with oils of sesame, arachis, cotton-seed, poppies, nuts, linseed, almond and peach kernels, and castor-oil, an intense though fugitive violet colour is formed. Attempts to replace resorcin by other phenols have not given satisfactory results up to the present.

Phloroglucin, which carries three hydroxylised groups, of which two are in the meta position, like resorcin, appears, however, *à priori*, to be able to possess the same property.

Still, if we operate with a cold benzolic solution of this triphenol, the results are negative on account of its slight solubility under these conditions.

On the other hand, its use either in the solid state or in ethereal solution, or hot benzolic solutions, gives rise to coloured reactions with the fatty acids. The best reactions are obtained with ethereal solutions at 1 per cent. If we place equal volumes of nitric acid, of density = 1·4, the oil to be examined, and the ethereal solution of phloroglucin, and then shake carefully, we notice with oils of arachis, sesame, cotton-seeds, nuts, peach kernels, and castor-oil, that the ethereal solution of the oil, which floats on the top, takes a magnificent raspberry-red colouration. Under these same conditions olive oil and lard and butter oils do not give any colouration, or at the most a pale reddish-yellow tint.

We can detect the same reaction by adding to the oil a little solid phloroglucin, then nitric acid of 1·4 density, and shaking the mixture.

Whenever we use this plan with oil of sesame, that is to say, if we place 0·05 grm. of phloroglucin in a test-tube, moisten it with 3 to 5 drops of the oil and shake up, after adding the same quantity of nitric acid, density = 1·4, we observe that the acid layer takes an intense greenish-blue colour, and the oil turns red. If at this moment we add ether, the latter becomes violet, then on shaking with a little water the last-named takes a deep blue colour, while the ethereal layer becomes reddish-brown.

Further, we can separate in the following manner the blue colouring principle, which is soluble in water:—Dilute the oil of sesame with four parts of tetrachloride of carbon; add to 2 c.c. of this solution about 0·01 grm. of phloroglucin and 1 c.c. of nitric acid of 1·4 density, then shake energetically. A greenish-blue colour is produced, of which the principle can be removed by shaking up with water, which takes an indigo-blue colour. We may mention also that resorcin, either in the solid state or in solution in chloroform, in the presence of oil of sesame,

gives analogous colourations, which disappear rapidly on the addition of ether and water.

In certain cases Bellier's reaction cannot be depended on, especially in the presence of old oils, which only give negative or very indistinct results. On the other hand, if these old oils are mixed with fresh oil of sesame, and hydrochloric acid of 1·19 density is added, a green colouration is formed, as described by Bishop for old oil of sesame. This action has been confirmed by the author for oils of arachis, poppy-seeds, nuts, peach kernels, cotton-seeds, and sesame. Phloroglucin behaves with old oils in the same manner as resorcin.

It results that Bellier's reaction, which is so valuable for the testing of olive oil, since it is the only coloured reaction of oil of arachis that we are aware of, is not absolutely conclusive when it is negative, as fraudulent makers might have recourse to oils not giving this reaction. In such a case, before giving a definite opinion, the olive oil must be shaken up with fresh oil of sesame and hydrochloric acid of 1·19 density, as indicated above, to make sure whether there is any production of the green colour or not.—*Revue International des Falsifications*, January-February, 1903.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month Ending February 28th, 1903.

By SIR WILLIAM CROOKES, F.R.S.,
and
PROFESSOR DEWAR, F.R.S.

To Charles Perrin, Esq., M.Inst.C.E.,
Water Examiner, Metropolis Water Act, 1871.

London, March 10th, 1903.

Sir,—We submit herewith, at the request of the Directors, the results of our analyses of the 196 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from Feb. 1st to Feb. 28th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water, as determined by the colour-meter described in previous reports.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 196 samples examined by us during the month, 194 were found to be clear, bright, and well filtered; one sample was clear, but dull, and one slightly turbid; this was due to a burst main, and had nothing to do with the filtration, which has been maintained at its usual high efficiency.

The rainfall at Oxford during February has been very low, only 0·01 inch of rain fell before the 21st of the month. The total rainfall was 0·79 inch, the average is 1·80 inches, leaving a deficit of 0·01 inch; this extinguishes the previous excess, and makes a deficit for the first two months of the year of 0·51 inch, or 13·1 per cent on the thirty-five years' average.

The colour of the water has improved, and so has the dissolved organic matter, chiefly of vegetable origin, although the latter is in excess of what it was during the corresponding month last year.

Our bacteriological examinations of 352 samples have given the results recorded in the following table; besides these samples we have examined 198 others from special wells, standpipes, &c., making a total of 550 samples in all:—

	Microbes per c.c.
New River, unfiltered (mean of 24 samples) ..	455
New River, filtered (mean of 71 samples) ..	8
Thames, unfiltered (mean of 24 samples) ..	15653
Thames-derived water, from the clear-water wells of eight Thames-derived supplies (mean of 185 samples)	23
Ditto ditto .. .. highest	245
Ditto ditto .. .. lowest	0
River Lea, unfiltered (mean of 24 samples) ..	254
River Lea, from the East London Company's clear-water wells (mean of 24 samples) ..	10

Of the 280 daily samples taken from the filter-wells of the Metropolitan Water Companies, and examined bacteriologically by us, eleven samples, or 4 per cent, were sterile; nine samples, or 3·2 per cent, contained more than 100 microbes per c.c.; and two of these samples contained more than 150 microbes per c.c. The mean number of microbes in the 3·2 per cent of samples containing more than 100 microbes was 144, against a corresponding mean of 198 in the 15·1 per cent of samples that contained more than 100 microbes during January. Thus the general microbic condition of the London supply has improved very considerably during the month of February.

We are, Sir,
Your obedient Servants,
William Crookes.
James Dewar.

THE LECITHANS: THEIR FUNCTION IN THE LIFE OF THE CELL.*

By WALDEMAR KOCH.

The ash left on the incineration of tissues obtained from various parts of the body, especially the brain, has long been known to contain phosphorus. Of the chemical combination in which this phosphorus was present in the original tissues nothing was known until Gobley (*Journ. de Pharm. et de Chim.*, 1850, vol. xvii., p. 401; and vol. xviii., p. 107) carefully studied an organic phosphorus-containing body, which he isolated from eggs and called lecithin. He obtained as splitting products glycerophosphoric acid and some of the fatty acids. Diaconow (Hoppe Seyler's "Medicinisch-chemische Untersuchungen," 1866, vol. ii., p. 221; also *Centralblatt für die Medicinischen Wissenschaften*, 1868, vol. vi., pp. 2, 97, and 434) continued this work at the suggestion of Hoppe Seyler, and isolated as splitting products glycerophosphoric acid, stearic and oleic acids, and a base which he identified with Baeyer's neurin and the neurin obtained by Liebreich (*Liebig's Ann. Chem.*, 1865, vol. cxxxiv., p. 34) from his protagon by decomposition with barium hydrate. From the ease with which his lecitin could be split up Diaconow concluded that it was a neurin salt of distearyl glycerophosphoric acid. This view was, however, disproved by Hundeshagen (*Journ. Prakt. Chem.*, 1883, vol. xxviii., p. 219) on account of the fact that the body prepared by the union of neurin and distearyl glycerophosphoric acid in alcohol solution would not give the characteristic myelin forms, although it possessed all the other properties of lecithin. Strecker (*Liebig's Ann. Chem.*, 1868, cxlviii., p. 78) brought confusion into this subject by identifying the base obtained by him from lecithin with the cholin he had isolated from bile (*Liebig's Ann. Chem.*, 1862, vol. cxxiii., p. 353). Thudichum ("Die Chemische Konstitution des Gehirns des Menschen

* From the *Decennial Publications of the University of Chicago*, 1902, vol. x.

und der Tiere," 1901, p. 123) pointed out the difference between the body derived from bile and the base isolated from lecithin, and identified the latter as neurin by a number of analyses made with carefully purified material. In the book above referred to Thudichum also records some other important observations. Among the large number of compounds isolated by him from the brain there are some which do not contain glycerin; as he always finds phosphorus in the form of orthophosphoric acid, he concludes to call these bodies "phosphatids" and consider them rather as derivatives of orthophosphoric acid than glycerophosphoric acid, as previously accepted. His formulæ resemble the types of the *Typentheorie* of Gerhardt and Wurtz, in leaving the exact building up of the molecule a matter of doubt. From a study of the fatty acids in his various compounds Thudichum concludes, contrary to Diaconow, that there are no phosphatids with only one fatty acid, but that each one contains either palmitic, stearic, or margaric as one of the constituents; which, however, gives no character to the molecule, while the other acid—oleic for brain lecithin, kephalinic for kephalin—gives to the molecule its distinctive properties.

Without considering further the important question of the structure of these compounds, I would propose to classify them under the general term "lecithans." The introduction of the word "lecithan" as a group name seems perferable to the use of an entirely new and unfamiliar term like "phosphatids," as proposed by Thudichum. At the same time, the change of the last syllable of lecithin to *an* gives sufficient variation to prevent any such confusion as attended the generalisation of the word "albumen." The lecithans, then, are substances containing in the molecule phosphoric acid, fatty acids, nitrogen, and, in most cases, glycerin. They resemble each other very closely in their physical appearance, being waxy, non-crystalline, and very hygroscopic. Toward water they all show the same behaviour, although their solubility or the solubility of their salts in *organic* solvents may vary.

The very general distribution of the lecithans in all forms of living tissues speaks for their value in the life of the cell. A more careful study of these compounds indicates that they are valuable in two ways:—First, on account of their physical properties; and, secondly, on account of their chemical behaviour.

Physical Properties.

The behaviour of the lecithans with water seems of especial interest, and can be watched under the microscope. A waxy piece of brain lecithin placed in water first swells up, and then gives off long filaments (called myelins) which sometimes resemble a shepherd's crook, at other times a mass of twisted skein. If allowed to stand for some time, with frequent shaking, a perfect emulsion is finally formed. A lecithan which has been part of the living tissues, such as brain lecithin, gives a much more perfect emulsion than egg lecithin, which is merely stored food material. If such an emulsion is the substratum of the living cell—and there seems good reason to consider it so—it may explain some of the physical properties of living protoplasm. The study of this emulsion is especially interesting in connection with the changes in the physical conditions of the living cell brought about by electrolytes, as shown by the recent work of J. Loeb and his school.

Action of Electrolytes on an Emulsion of Brain Lecithin.—Four g. of brain lecithin (free from calcium, and containing less than 1 per cent sodium or potassium) are treated with one litre of distilled water. The resulting emulsion is sufficiently transparent for purposes of study, can be filtered unchanged, has a neutral reaction to litmus, and remains unaltered for weeks, especially after sterilisation by boiling. The results of my experiments with this emulsion may be classified as follows:—

Univalent Kations.—Salts of Na, K, NH_4, Li, Ag, even in very concentrated solution, give no precipitate, and have apparently no effect on the emulsion. The hydrogen ion is an exception, in the case of acids which are sufficiently dissociated. A concentration of *m*/200 sulphuric will give a precipitate. Carbonic acid is not sufficiently soluble to give any precipitate.

Divalent Kations.—Mg, Ca, Sr, Ba, Co, Ni, Fe", Zn, Cd, Cu, and Pb all give a precipitate which, similar to the one with acids, is flocculent, gelatinous, and settles to the bottom in less than one hour, leaving the supernatant liquid perfectly clear. The concentrations which will just give the precipitate vary somewhat, and have been found in the case of Ca, Sr, and Ba to be *m*/100, *m*/40, and *m*/30, respectively.

Trivalent Kations.—Fe‴, Al, Au give no precipitate, and behave like monovalent kations. Cr gives unsatisfactory results. Au, after standing for several hours, is precipitated in the metallic state.

Anions.—Cl, Br, I, SO_4", *oxalate*, *citrate*, and *ferrocyanide*, $K_4Fe(CN)_6$, give no precipitate, and even in concentrated solution have no apparent effect on the emulsion. OH is an exception, causing the emulsion to clear up.

Non-electrolytes.—Albumins, peptones, glucose, urea, alkaloids, and narcotics like urethan and chloral, give no precipitation reactions and leave the emulsion apparently unchanged. Chloroform has a tendency to be emulsified by the emulsion, a reaction which Thudichum had already observed with ether.

The precipitations above observed with the hydrogen ion and divalent kations seem to be of an entirely physical nature because:—

1. They are independent of the concentration of the lecithin. An *m*/2000 lecithin emulsion will begin to precipitate with about the same concentration of the divalent kation as an *m*/200 emulsion. Stronger emulsions are not sufficiently transparent for observation.

2. Removal of the supernatant liquid by decantation and the addition of water will cause the precipitates to redissolve.

Cadmium, copper, and other salts of various lecithans have been prepared in alcohol solution and analysed, but they are readily broken up on the addition of water, and belong to a class of physical compounds even more unstable than ordinary double salts. It would seem, then, that when a certain limiting concentration of the divalent kation is reached, the emulsion can no longer exist, and the lecithin is precipitated, carrying with it possibly some of the salt. Very interesting, on account of the possibility of furnishing an explanation of such results as Loeb (*Amer. Journ. Phys.*, 1902, vol. vi., p. 411) obtains with Fundulus, are the antagonistic effects of univalent kations in preventing the precipitation. Near the limits at which Ca will just give a precipitate, a very small amount of Na will suffice to prevent this precipitate; as more Ca is added, relatively more Na is needed. A direct comparison of my results with J. Loeb's is not possible, because, in the first place, the amounts of Ca, Na, and lecithin in the Fundulus egg are not known, and, in the second place, the reaction between the solution and the egg does not come about as directly as in my case. The accompanying table gives the data obtained with an emulsion of brain lecithin.

We may conclude, then, that the precipitation of lecithin by divalent kations is a physical phenomenon probably of an electrical nature, because:—

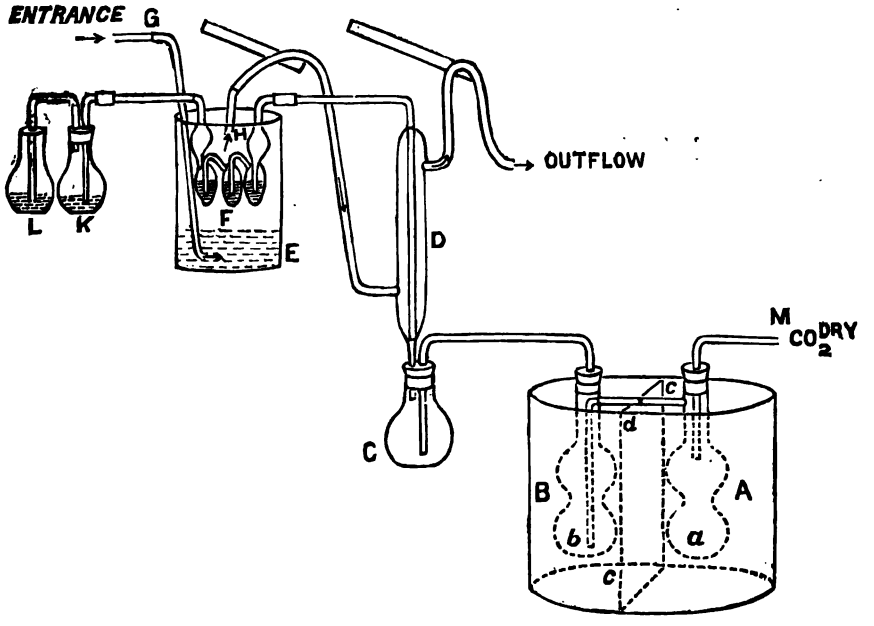
1. Non-electrolytes do not prevent the precipitation (I., VIII., IX.).

2. The trivalent kation Fe‴ is much more efficient in preventing the precipitation than a monovalent one like Na (II., VII.).

3. The precipitate is formed independent of the concentration of the lecithin, and can be re-dissolved by the addition of water.

The application of these observations to Loeb's results must be postponed until other lecithans have been more carefully studied.

						Immediate.	After three hours.
I.	5 c.c. *m*/200 emul.	+	5 c.c. water	+	5 c.c. *m*/10 $Ca(NO_3)_2$..	Immediate ppt.	Ppt. settled.
II.	,, ,,	,,	5 *m* NaCl	+	5 c.c. *m*/10 $Ca(NO_3)_2$..	No ppt.	No ppt.
III.	,, ,,	,,	*m*/10 NaCl	+	1·5 c.c. *m*/10 $Ca(NO_3)_2$..	No ppt.	No ppt.
IV.	,, ,,	,,	*m*/10 NaCl	+	5 c.c. *m*/10 $Ca(NO_3)_2$..	Immediate ppt.	Ppt. settled.
V.	,, ,,	,,	*m*/10 NaCl	+	3·5 c.c. *m*/10 $Sr(NO_3)_2$..	No ppt.	No ppt.
VI.	,, ,,	,,	2½ *m* KCl	+	5 c.c. *m*/10 $Ca(NO_3)_2$..	No ppt.	No ppt.
VII.	,, ,,	,,	*m*/10 $FeCl_3$	+	5 c.c. *m*/10 $Ca(NO_3)_2$..	No ppt.	No ppt.
VIII.	,, ,,	,,	urea conc. sol.	+	5 c.c. *m*/10 $Ca(NO_3)_2$..	Ppt. formed slowly.	Ppt. settled.
IX.	,, ,,	,,	glucose conc. sol.	+	5 c.c. *m*/10 $Ca(NO_3)_2$..	Ppt. formed slowly.	Ppt. settled.



Chemical Properties.

The chemical properties of the lecithans depend on two groups in the molecule:—First, the fatty acids, and, second, the complex of which the nitrogen is a part. The phosphoric acid, although the nucleus and very important in the building up of the molecule, does not seem to enter into any reaction, except on the complete destruction of the lecithan; as Halliburton ("The Chemical Side of Nervous Activity," 1901, p. 87) has found the phosphorus to decrease in degenerating nerves only after the eighth day.

Each lecithan contains, according to Thudichum, two fatty acids in the molecule:—One—either palmitic, stearic, or margaric—does not impart any particular property to the compound; the other—oleic in the case of lecithin, kephalinic in the case of kephalin—gives to the molecule its distinctive character. This distinctive group is always unsaturated, will therefore add iodine, and bring about the reduction of osmic acid. Upon this group, then, depends the use of osmic acid as a stain for nervous tissues in histological technique. The value of osmic acid as a general test for fats depends on the fact that all fats in the body contain some oleates. Pure stearates and palmitates will not give the test. The darkening of the lecithans on exposure to the air is also dependent on this group. In the case of kephalin, the change on exposure to the air takes place so rapidly as to suggest an autoxidisable substance capable of activating oxygen. The guiac-blue reaction, however, gives a negative result; and Thudichum (*op. cit.*, p. 128) has shown that kephalin exposed to an atmosphere of oxygen in a eudiometer will not decrease the volume of the gas. The change is probably due to an internal re-arrangement in the molecule, and takes place within the molecule of the fatty acid itself; as Thudichum (*Ibid.*, p. 149) obtained from kephalin an acid by saponification (kephalinic acid) which exhibited the same changes as the mother-substance.

Less apparent, but nevertheless important, are the changes which the molecules of the lecithans undergo in the complex which contains the nitrogen. Thus Halliburton (*op. cit.* p. 50) has found the cholin to increase in the cerebro-spinal fluid as the result of general paralysis. For the quantitative investigation of the cholin or neurin, the methyl groups attached to the nitrogen seem especially useful, as Herzig and Meyer (*Monatshefte für Chem.*, vol. xv., p. 613) have devised a method by which such groups can be accurately determined. The description of the method is not easily accessible. I will therefore repeat it here, with such modifications as have been found useful, before going on to describe the results obtained with lecithans from various sources.

Herzig and Meyer's Determination of Methyl attached to Nitrogen.

The apparatus consists of a double glass bulb, 4 c.m. wide at the largest diameter and 2½ c.m. at the narrowest diameter, and 12 c.m. high. The bulb *a* is connected to *b* by a glass tube which runs to the bottom of *b*. The double bulbs are placed in an iron sand-bath with double bottom and a partition, *c d*, so that *a* can be heated in sand, while *b* remains comparatively cool. C is a flask for catching the distillation products from the bulbs, and D is a condenser kept at a temperature of from 40° to 50° C. E is a beaker into which the water enters at G, is heated to a temperature of from 40° to 50° C. by a Bunsen burner, and is drawn off by means of a syphon at H, to enter the condenser D and keep it at the proper temperature. By regulating the flow of the water and the height of the flame, the temperature of the water can easily be kept within the required limits. F are Geissler bulbs for absorbing everything but the methyl iodide, which is

absorbed in K and L. The analysis is carried on as follows:—0·2 g. of the substance to be analysed is placed in *a* with 2 g. of dry ammonium iodide and enough hydriodic acid (sp. gr. 1·6) to half fill the lower bulb. In *b* is placed 1 g. of ammonium iodide. The part A of the sand-bath is filled with sand, and a thermometer reading to 360° C. placed in the sand. A stream of dry CO_2 is allowed to enter at M, and when all the air is displaced, a triple burner is lighted under the sand-bath. In the meanwhile the water must be started and kept running through the condenser D at a temperature of from 40° to 50° C. As the temperature of 200° C. is reached in the sand-bath, methyl iodide begins to split off, and is carried over by the CO_2, mixed with hydriodic acid and iodine. Most of the iodine and hydriodic acid is condensed at D and collected in C. Some passes over and is absorbed in F, which contains the following solution:—

Sodium carbonate	1 part
Potassium arsenite	1 part
Water..	10 parts

The methyl iodide passes on and is collected in K, which contains 2 g. of silver nitrate dissolved in 5 c.c. water and 45 c.c. absolute alcohol. The methyl iodide dissolves in the alcohol, and is decomposed by the silver nitrate with the formation of silver iodide. After some time the temperature in the sand-bath gradually rises to 240° C., and after a little while longer methyl iodide ceases to come over, as can be seen by the liquid in K becoming perfectly clear. L, which also contains silver nitrate, is used merely as a guard. The solution can be removed at this point, and the silver iodide collected corresponds to all the kephalin and one methyl group of the lecithin. Fresh silver nitrate is placed in K, another burner placed under the sand-bath, and the temperature raised to 300° C. The remaining two methyl groups of lecithin come over, while kephalin gives off no more, or only a trace of methyl iodide. The second part of the sand-bath, B, is now filled with sand and heated to 300° to decompose anything which may have escaped previous heating. The two alcoholic solutions containing the silver iodide are diluted with much water and warmed for several hours on a steam-bath to remove alcohol. Strong nitric acid is then added, and the silver iodide filtered into a Gooch crucible and weighed. In case we are not dealing with a mixture of lecithans, all the silver iodide can be weighed in one portion.

(To be continued).

Reaction between Nitric and Hydriodic Acids.—Adolf Eckstadt.—The examination of the reaction which takes place between nitric and hydriodic acids offers numerous difficulties. The rapidity of the reaction is actually increased by the presence of germs, and towards the end of the reaction by the precipitation of colloidal iodine. It is further augmented by the oxidation of the products of the reduction of the nitric acid by the atmospheric oxygen. The author has examined the action of both nitrous and nitric acids on hydriodic acid. In the absence of air the former may be formulated as follows:—$(H_2)' + I' + (NO_2)' = H_2O + I + NO$ or $N(OH)_3 + HI = NO + 2H_2O + I$. The second is represented by the equation $(NO_3)' + 2H' + 2I' = (NO_2)' + H_2O + 2I$ or $N(OH)_5 + 2HI = N(OH)_3 + 2H_2O + I_2$. The presence of ferrous ions certainly causes an acceleration of the reaction. This result may be interpreted by the help of the hypothesis of a ferro-hydriodic acid, an hypothesis analogous to that which serves to explain the reaction between permanganate and hydrochloric acid. The absence of all catalytic acceleration in the presence of the other metallic salts may be compared with the neutralising action of the manganese salts on the permanganate + HCl reaction. The salts on which the experiments have been carried out are the nitrates of the following metals:—K', NH_4', Be", Ba", Mg", Zn", Cd", Ni", Co", Mn", Fe", Te_4O_7", VO_2"', Al"', Cr"', Fe"', Th"" —*Zeit. Anorg. Ch.*, vol. xxix., p. 51.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, March 5th, 1903.

Dr. W. H. PERKIN, F.R.S., Vice-President, in the Chair.

(Concluded from p. 141).

39. "*The Rate of Decomposition of Diazo-compounds. Part III. The Temperature Coefficient.*" By J. C. CAIN and F. NICOLL.

The authors have determined the temperature coefficients by the use of Arrhenius's formula,—

$$C_{t_1} = C_{t_0} e^{A(T_1 - T_0) : T_1 T_0},$$

the values of C being calculated from the formula—

$$\frac{1}{t} \log \frac{A}{A - x} = C,$$

as indicated in their earlier communications (*Trans.*, 1902, lxxxi., 1412; 1903, lxxxiii., 206).

The values of A for diazobenzene-*p*-sulphonic acid and the chlorides of diazobenzene, diazo-*o*-toluene, diazo-*m*-toluene, diazo-*p*-toluene, and diazo-*m*-nitrobenzene do not vary much from each other, and agree with those found by Euler (*Annalen*, 1902, cccxxv., 301) for diazobenzene chloride (11905) and diazo-*p*-bromobenzene chloride (13634). By the use of the temperature coefficients thus obtained, the value of C at other temperatures has been calculated in several cases, and shown to be in agreement with the numbers found by other observers.

40. "*An Analysis of the Natural Gas at Heathfield, Sussex.*" By H. B. DIXON and W. A. BONE.

When the possibility of the industrial application of the Heathfield natural gas was brought before the Royal Commission on Coal Supplies, one of the authors (H. B. D., a member of the Commission) was asked to visit Heathfield and examine the nature of the gas on behalf of the Commission. Accordingly, several samples of gas were collected and sealed up in glass tubes on October 10th, 1902, and brought to Owens College for analysis.

According to Mr. Richard Pearson, Managing Director of the "Natural Gas Company," the gas was first discovered in 1836 in a well which was being sunk at Hawkhurst in West Sussex. In the Sub-Wealden boring (1873—1875), the gas was met with at Netherfield on the South Eastern Railway. Gas was first encountered at Heathfield in 1895 in sinking a well for water in the hotel yard, about 50 yards from the station. In 1896, the same firm of well sinkers met the gas at a depth of 300 feet in a shaft sunk for water at the station; no water was found, but the gas continued to escape, and was then used for lighting the station.

At the date of the above visit, six wells were either sunk or in course of being sunk, and gas had been encountered in all of them after the bores had penetrated through the 300 or 400 feet of surface bed of sandstone and marl which forms, according to Mr. Pearson, the impervious lid to the natural holder of gas.

The gas was issuing from the bore holes at a pressure of between 140 and 200 lbs. per square inch, and was being used to drive gas-engines and to light (with incandescent mantles) the station and a number of houses in the village. When lighted at an inch pipe at the mouth of a bore-hole, the gas burnt with a large flame giving a fairly good light, the flame being more luminous than that of fire-damp from coal mines. In an argand burner, the gas burnt with a moderately luminous flame, but gave little light in an ordinary bats-wing, so that it was difficult to understand how the gas could contain 5½ per cent of ethylene, as was stated, unless, indeed, the free oxygen, also said to be present, was sufficient to destroy its lighting power. The analyses, however, showed that neither ethylene nor free oxygen was present in the gas collected. To avoid the

possible loss of free oxygen by partial combustion in the tube while the drawn-out ends were being sealed, a sample was collected by closing the ends of the tube with paraffined indiarubber; it gave the same result.

The gas was transferred by means of a Töpler pump from the collecting vessels into small tubes standing over mercury. The analyses were made over mercury in a modified McLeod apparatus, all the reagents being freshly prepared.

A. *Preliminary examination for carbon dioxide, oxygen, unsaturated hydrocarbons, and carbon monoxide.*

1. The absence of carbon dioxide and oxygen was proved by exposing the gas successively to the action of (*a*) strong potassium hydroxide solution and (*b*) strongly alkaline pyrogallol solution. In neither case was there any appreciable absorption.

2. The absence of unsaturated hydrocarbons was shown in two separate experiments in which samples of gas were successively treated with (*a*) fuming sulphuric acid and (*b*) strong potassium hydroxide solution. No change in volume occurred in either experiment.

3. The gas always showed an appreciable contraction (as nearly as possible 1 per cent) when successively treated with ammoniacal cuprous chloride and dilute sulphuric acid. No precipitate of cuprous acetylide was formed. Since the foregoing experiments exclude the possibility of this contraction being due to oxygen or unsaturated hydrocarbons, it can only be attributed to the presence of carbon monoxide.

B. *Explosion analyses for saturated hydrocarbons, with, possibly, hydrogen, after removal of carbon monoxide.*

After removing the carbon monoxide from a considerable volume of the gas (by means of ammoniacal cuprous chloride and dilute sulphuric acid), the contraction, C, obtained on exploding measured volumes of the residual gas with a large excess of oxygen and air, was determined, and also the absorption, A, when the products of explosion were subsequently treated with strong potassium hydroxide solution. The following results were obtained:—

	1.	2.	3.
Volume of gas taken (corr.) .	48·25	55·70	58·75
Volume of oxygen and air added	457·45	468·30	465·45
C	94·35	109·10	115·20
A	48·25	55·90	58·80
C/A	1·956	1·952	1·959

C. *Proof that the gas does not contain free hydrogen.*

Before the foregoing results could be interpreted, it was necessary to ascertain whether the gas contained free hydrogen. This was done by exposing some of the gas, after removing carbon monoxide, to the action of "oxidised" palladium sponge at 100° for twenty minutes in an apparatus similar to that described by Bone and Jerdan (*Trans.*, 1901, lxxix., 1044), and afterwards redetermining the ratio C/A, when the residual saturated hydrocarbons were exploded with excess of oxygen and air. The results obtained were as follows:—

	4.	5.
Volume of gas taken (corr.)	62·3	55·3
Oxygen and air added	472·5	493·0
C	121·8	108·2
A	62·2	55·4
C/A	1·958	1·953

A comparison of these numbers with those given above shows clearly that the gas contains an appreciable quantity of free hydrogen. The five explosion analyses indicated, however, the presence, besides methane, of a small proportion of some higher saturated hydrocarbon, which is probably ethane. Assuming this to be the case, the percentage composition of the gas, after removing carbon monoxide, calculated from the five analyses, is as follows:—

	1.	2.	3.	4.	5.	Mean.
Methane	94·10	93·88	94·40	94·30	93·90	94·10
Ethane .	2·95	3·23	2·77	2·76	3·13	2·97
Nitrogen (by difference)	..	..	..	..	..	2·93
						100·00

The original gas, therefore, had the following composition:—

Carbon monoxide	1·00
Methane	93·16
Ethane	2·94
Nitrogen, or other inert gas (by difference) ..	2·90
	100·00

41. "*Chemical Composition of Cooked Vegetable Foods.*" By Miss K. I. Williams.

The following constituents:—Water; total nitrogen (by Kjeldahl's method, modified to include the nitrogen of nitrates); ash; sulphur; phosphorus; cellulose (by Schulze's potassium chlorate method); woody fibre (by digestion with dilute sulphuric acid); carbohydrates convertible into dextrose; fat; and waste—were estimated in a series of vegetable foods including broccoli, Brussels sprouts, dried peas, oatmeal (coarse Scotch), and macaroni. These determinations being carried out on both the raw and the cooked materials.

42. "*The Density of Nitric Oxide.*" Preliminary Notice. By R. W. Gray.

It seemed doubtful whether nitric oxide had been obtained in a state of sufficient purity to admit of the accurate determination of its density and other physical constants. The value obtained by Leduc (*Comptes Rendus*, 1893, cxvi., 322) for the density does not agree absolutely with the value found by Victor Meyer and Daccomo (*Annalen*, 1887, ccxl., 326), while Olszewski's results (*Comptes Rendus*, 1885, c., 940) for the vapour pressures of the liquefied gas certainly suggest the possibility of impurity in the sample he used.

Nitric oxide, when prepared by many of the usual methods, contains small quantities of nitrous oxide and nitrogen. The higher oxides of nitrogen which are generated at the same time are apparently completely absorbed when passing through tubes containing potassium hydroxide in solution and in the solid form, and the gas then liquefies to a blue liquid which does not change in tint after repeated fractionation. The nitrogen present cannot be entirely removed by solidifying the nitric oxide by means of liquid air and pumping off the uncondensed gas; a small quantity remains behind in the solid nitric oxide, and can only be removed by liquefying and allowing a large portion of the liquid to boil away.

Owing to the ease with which liquid nitric oxide becomes superheated, it was found impossible to separate by fractionation the nitrous oxide present unless the upper part of the bulb containing the liquefied gas was kept below the melting temperature of solid nitrous oxide. When this was done, the densities of different fractions of the gas were found to agree.

The mean value for the weight of 1 litre of nitric oxide, prepared in two different ways, is 1·3402 grms. at 0° and 760 m.m. pressure (lat. Paris).

Until confirmed by further experiments, this value is not considered as final, but it is interesting to note that, assuming the truth of Avogadro's law for oxygen and nitric oxide under standard conditions of temperature and pressure, the ratio of the atomic weights so deduced for oxygen and nitrogen is 16 : 14·001.

The work is being continued with the object of making further experiments on the density of this gas and of determining its compressibility and other physical constants.

43. "*Hydrolysis of Urea Hydrochlorides.*" By J. Walker and J. K. Wood.

A comparison method was described which permits the hydrolysis of a salt such as urea hydrochloride to be determined by the catalysis of cane sugar or methyl acetate with an error not exceeding 1 per cent; the results obtained with these two compounds being identical.

Within the limits 25—40°, temperature has practically no influence on the hydrolysis of urea hydrochloride.

The influence of dilution on the degree of hydrolysis x is expressed by the relation $\frac{x^2}{(1-x)v}$ = constant.

The addition of sodium chloride very slightly diminishes the value of x.

The dissociation constant of urea, calculated from the hydrolytic experiments, is $1{\cdot}5 \times 10^{-14}$ at 25°.

44. "*The Affinities of some Feebly Basic Substances.*" By J. K. WOOD.

By means of the methyl acetate method, together with some solubility experiments, the author has obtained the following results at 40·2°:—

Base.	Percentage hydrolysis of hydrochloride in decinormal solution.	Dissociation constant.
Creatinine	8·96	$3{\cdot}57 \times 10^{-11}$
Acetoguanamine	9·8	2·96 ,,
Semicarbazide	10·4	2·61 ,,
Glycocyamine	11·0	2·32 ,,
Creatine	12·3	1·81 ,,
Guanine	17·9	0·81 ,,
Acetonesemicarbazone ..	26·9	0·32 ,,
Acetoxime	34·3	0·175 ,,
Aminocaffeine	55·0	0·047 ,,
Theobromine	73·0	0·016 ,,
Dimethylpyrone	85·0	0·0065 ,,
Xanthine	88·5	0·0046 ,,
Acetanilide	88·9	0·0044 ,,
Caffeine	89·7	0·0040 ,,
Urea	90·4	0·0037 ,,
Acetamide	91·3	0·0033 ,,
Nitroguanidine	94·0	0·0021 ,,
Propionitrile	97	—
Cyneol	98	—
Biuret	>99	—
Benzamide	>99	—

PHYSICAL SOCIETY.

Ordinary Meeting, March 13th, 1903.

Dr. R. T. GLAZEBROOK, F.R.S., President, in the Chair.

A PAPER by Dr. FARR, "*On the Interpretation of Milne Seismograms*," was read by Dr. CHREE.

Professor Milne and Dr. Omiri have come to the conclusion that the tilts represented by the maximum displacement of the boom of a horizontal pendulum seismograph are too large to be admissible as true tilts. The author has investigated the motion of the boom analytically, and his results show:—(1) That the boom does not vibrate with its own natural period, but takes the frequency of the disturbing force; (2) that the friction should be small compared with the difference of the squares of the frequencies; and (3) that the phenomenon of beats may occur between the forced vibration and the free period of the boom. The maximum amplitude of swing of the boom gives no information whatever of the amplitude of the disturbing cause without also a knowledge of the periods of the forced and free vibrations. The author shows how to determine the amplitude of the wave by observations on these quantities. The author has verified the results of his analysis by experiments with artificial waves of known periods produced by an apparatus described in the paper. In conclusion, it appears (1) that strict attention should be paid to accurately recording the period of free vibration of the boom; (2) that the tape should be driven at such a speed as to enable the period of forced vibration to be determined; (3) that the effect of friction should be recorded.

The CHAIRMAN said the paper brought out clearly the possibility of interference between the periods of the boom and the earthquake tremors.

Prof. PERRY said that, if possible, the period of the pendulum should be very different to that of the wave. The period might be made very great or excessively small, but there would probably be difficulties in either case.

Prof. EVERETT said it was obvious that the records could not easily be interpreted unless there was a great difference between the periods. He suggested the use of two booms having different periods.

Dr. WATSON pointed out that the boom would respond equally well to any period if it was heavily damped. Fluid damping was unsatisfactory because of convection currents, and he suggested that the plate at the end of the boom should be made of copper and allowed to move between the poles of a strong horseshoe magnet.

Dr. CHREE said that if the period of the boom was increased beyond eighteen seconds, the apparatus became too sensitive, and was unstable.

"*A Potentiometer for Thermocouple Measurements*" was exhibited and described by Dr. LEHFELDT.

To make a satisfactory potentiometer for thermoelectric work, it is essential that it shall not introduce a high resistance in the circuit of the couple and galvanometer. Most of the potentiometers on the market, though good enough for comparing voltaic cells, fail in this respect. Dr. Lehfeldt has therefore designed an instrument specially suited for thermocouple work. From the positive terminal of an accumulator a current flows to a switch, by means of whichsit can be sent through 100, 1000, or 10,000 ohms in order to get three grades of sensitiveness; it then passes through 20 coils of 0·1 ohm each, a slide-wire of a little more than 0·1 ohm, and through an adjustable resistance back to the accumulator. The fixed resistance of 100, 1000, or 10,000 ohms is shunted by a cadmium cell and a galvanometer, and the adjustable resistance varied until balance is obtained. The thermocouple and the galvanometer are then put across any number of the tenth-ohm coils, and any fraction of the slide-wire. Great care has been taken to avoid accidental thermo E.M.F.'s, which are the chief trouble in using thermocouples. The only metals used in the measuring-circuit are copper and manganin. The position of the sliding-contact upon the bridge-wire can be read by means of a vernier to $\frac{1}{10}$ m.m. corresponding to $\frac{1}{2000}$ of the unit employed, which may be 1000, 100, or 10 microvolts according to the fixed resistance used. The paper concludes with a description of the calibration of the various parts of the instrument and of the precautions to be taken when using it.

Dr. J. A. HARKER exhibited and described "*A Direct-reading Potentiometer for Thermoelectric Work.*"

The instrument represents a form which has been designed and made in the National Physical Laboratory. Dr. Harker has experienced similar difficulties to Dr. Lehfeldt, and the instrument which he has designed is similar in many respects to the one described in the previous paper. The main current from an accumulator flows through a series of resistances, any one of which can be short-circuited at will, and then through the balancing-coils. By means of the adjustable resistance the standard cell employed can easily be made to cut off from the main circuit a resistance numerically equal to 100 times its E.M.F., and therefore 1 ohm on the potentiometer-circuit is equal to $\frac{1}{100}$ volt, always. The balancing-coils consist of 20 coils of 0·1 ohm each in series with 11 coils of 0·01 ohm each. Any two of these latter coils can be put in parallel with a slide-wire of 0·02 ohm resistance. The slide-wire is provided with a scale of 200 divisions, and as the fall along the wire is 100 microvolts, 0·1 microvolt can

easily be estimated. The slide-wire acts as a vernier to the small coils. Copper and manganin are the only metals used, and the connections are made by means of mercury cups.

Mr. W. A. Price said there was a great similarity between all forms of potentiometers. Electrically they were the same, but they differed mechanically. He referred to the large number of coils requiring calibration in the instruments exhibited. In working with sliding-contacts in a dusty workshop, it is an advantage to immerse the bridge in paraffin oil. The contacts are then always good, instead of uncertain and intermittent. He had also found that if two silver surface plates were screwed together, the contact-resistance was less when they were immersed in paraffin than when they were in air.

Mr. Whipple said he had also found that contact-resistances in oil were less than in air, The oil acts as a lubricator, keeps the temperature constant, and the wires wear less.

Dr. Watson said the effect of the oil seemed to depend upon the shape of the surfaces in contact, or it ought to be an advantage to grease the plugs of resistance-boxes. After what Mr. Price had said with regard to the contact-resistance of two pieces of silver, it would be interesting to work with a resistance-box in which the plugs were immersed in paraffin oil.

Prof. Everett expressed his interest in the fact that an insulating material, such as paraffin, should decrease the contact-resistance between two metals. He suggested that the paraffin drives off the film of air from the metals.

Dr. Harker asked Dr. Lehfeldt if he had worked with all three sensitivities, and pointed out that the middle one was the same as that adopted in his own instrument.

Dr. Lehfeldt said that for small voltages he used the highest sensitivity. Inequalities in the slide-wire amounted to about $\frac{1}{20}$ m.m. of wire. The open scale in Dr. Harker's instrument was convenient in place of a vernier.

A paper on "*The Measurement of Small Resistances*" was read by Mr. A. Campbell.

The object of this paper is to give a brief account of a number of measurements of a set of low resistance standards belonging to the National Physical Laboratory. The tests were made partly with a view to comparing various methods of measurement. The resistances were of manganin, and their nominal values were approximately 0·1, 0·01, 0·001 international ohms. The following methods were employed:—(1) Shunt potentiometer; (2) Kelvin bridge; (3) two-step bridge; (4) differential galvanometer; (5) Matthiessen's and Hockin's method. The last method was found to be much less accurate than the other four. The results obtained from the other methods are tabulated in the paper, and show very satisfactory agreement.

Dr. R. A. Lehfeldt read a paper on "*A Resistance Comparator.*"

Objecting to sliding-contacts on account of the thermo-electric effects they tend to introduce, and irregularities slide-wires show when a good deal used, the author has substituted for the slide-wire two coils of 99 ohms each connected by 20 coils of 0·1 ohm each. The latter are arranged circularly, so that a switch connected to the galvanometer may be set on any one of the intervening studs. The galvanometer deflections are taken for the two positions nearest balance and interpolation to $\frac{1}{100}$ calculated. In this way an accuracy of one part in 100,000 is attainable. The author thinks there is a gain of accuracy as well as of convenience in using the interpolation method.

The Thio-acids, RCOSH.—V. Auger and M. Billy.—The authors use Kekulé's method for obtaining the salts of the thio-acids by saponification of NaHS, and they find that the ether salts contain an alcohol group always giving mercaptans.—*Comptes Rendus*, cxxxvi., No. 9.

NOTICES OF BOOKS.

The Physical Papers of Henry Augustus Rowland, Ph.D., LL D., Professor of Physics and Director of the Physical Laboratory in the Johns Hopkins University, 1876-1901. Collected for Publication by a Committee of the Faculty of the University. Baltimore: The Johns Hopkins Press. 1902. Pp. 704.

In deciding on the scope of this volume, which has been compiled as a Memorial to the late Professor Rowland, the Committee appointed to arrange the matter decided to include only the distinctly Physical papers.

Professor Rowland's first published paper was a letter to *The Scientific American* in 1865, when he was only sixteen years of age. He himself declared that he did not expect it to be published, having written it for a joke. The subject chosen was "The Vortex Problem." His first paper of importance was "On Magnetic Permeability, and the Maximum of Magnetism of Iron, Steel, and Nickel," published in the *Philosophical Magazine* in the year 1873. The value of this paper was at once recognised by European physicists, and Rowland at once took high rank as an investigator, in Europe at any rate.

Important papers on electrical and magnetic subjects followed rapidly, and these included many of practical value besides those of purely theoretical interest.

But electricity was not the only subject touched by this gifted investigator; his papers on heat and light are well known, and those connected with the practical manufacture of gratings for optical purposes are of world-wide renown. The great fault in gratings, up to the time when Rowland took the matter up, was want of uniformity in spacing. He saw, as others had seen before him, that the dominating element of a ruling-machine was the screw by means of which the cutting tool or plate was moved along. The ruled plate would repeat all the irregularities of the screw, and the problem was to make a screw which would be practically free from periodic and other errors. He was not long in devising a method, that of grinding, which astonished everybody by its simplicity and almost absolute perfection of its results; indeed, the very first screw made by this process still ranks as the most perfect in the world.

As a chemist, Professor Rowland carried on investigations for several years on the so-called "rare earths," such as yttrium, erbium, cerium, &c., and devised several methods for their separation; the paper in which he published these results was printed in the *Johns Hopkins University Circulars*, 1894, No. 112, p. 73.

Towards the end of this volume there are given six Addresses read before different societies between 1883 and 1900; and the last paper of all is an illustrated description of the dividing engines designed by Professor Rowland.

There are altogether seventy papers and addresses included in this volume, and they form a lasting memorial of the untiring energy and genius of their writer. The book is well printed in large type, well bound, and as a frontispiece contains an excellent portrait of the originator of all it holds.

Principles of Inorganic Chemistry. By Harry C. Jones, Associate Professor of Physical Chemistry in the Johns Hopkins University. New York: The Macmillan Company. London; Macmillan and Co., Ltd. 1903. Pp. 521.

During recent years the theory of inorganic chemistry has undergone modifications; it is becoming more mathematical, and several new generalisations have been added to those already known. The more important of these generalisations are:—The theory of electrolytic dissociation, the law of mass action, the phase rule, and Faraday's law as the basis of chemical valence. The

importance of ions in chemical reactions has become more widely recognised, and this, says the author, necessitates a fundamental change in our conceptions of chemical phenomena. The application of Faraday's law as the basis of chemical valence is not new, but the importance of the application has only recently become apparent. The importance of ions, which are charged atoms or groups of atoms, and the study of electro-chemical phenomena in general, have made prominent the fact that the law of Faraday is a fundamental law of chemistry as well as of physical chemistry.

It must not be supposed, however, that the author abandons the older ideas; on the contrary, his aim is to add to the older generalisations those recently discovered, and to combine them into a harmonious whole.

The book, which is a large one, is divided into forty-one chapters, the greater number of which are devoted to the study of individual elements, or groups of closely allied elements, and their compounds; the first two chapters being devoted to the relations between chemistry and physics, the number of chemical elements, and generalisations, such as the law of mass, the laws of constant and multiple proportion, the correlation and conservation of energy, &c.

Chapter VIII. is an important one, on osmotic pressure and the theory of electrolytic dissociation. It is only in the past two or three years that the subject of osmotic pressure has come into prominence, although its existence has been long recognised; but in the hands of certain workers, such as van't Hoff, it has thrown a good deal of light on chemical phenomena in general. Van't Hoff has been followed up by Arrhenius, and he has satisfactorily solved the problem of the large number of exceptions to the generalisations reached by van't Hoff connecting gas-pressure and osmotic pressure. The new feature introduced by Arrhenius was to point out a method for determining just what per cent of the molecules is broken down into ions, and he thus converts a purely qualitative suggestion into a quantitative theory, which could be tested experimentally.

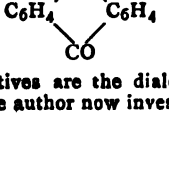
This theory is the governing idea of the rest of the book, and though some may hesitate before accepting it, the broad fact remains that the reactions and properties of the elements and their compounds, as herein described, remain as before; in other words, the chemistry remains the same, but the theories and explanations are amplified.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 9, March 2, 1903.

Preparation and Properties of the two Tetra-alcoyldiamidodiphenylanthrones.—A. Haller and A. Guyot.—Under the name of diphenylanthrone the authors described some time ago a compound, $C_{26}H_{18}O$, obtained by condensation of di-symmetric phthalyl tetrachloride with benzine in presence of aluminium chloride. This compound has since been prepared by several methods, and is found to have the formula—



Amongst its derivatives are the dialcoylamidodiphenylanthrones, which the author now investigates.

Heat of Combustion of Phosphorus. Phosphoric Anhydrides.—H. Giran.—The author measures the heat of combustion of white phosphorus in Mahler's calorimeter in presence of oxygen under a pressure of 15 or 20 atmospheres, and +369·4 cals. is the number obtained. He also measures the heat of solution of the anhydride obtained in the same experiments, +34·37 cals. On the other hand, when the three varieties of phosphoric anhydride are dissolved in water the numbers obtained are—

P_2O_5 cryst. + aq = P_2O_5 diss. +40·79 cals.
P_2O_5 amorph. + aq = P_2O_5 ,, +33·81 ,,
P_2O_5 vitreous + aq = P_2O_5 ,, +29·09 ,,

From this it can be shown that white phosphorus burnt under the above conditions gives the amorphous variety of oxide. Finally, the author obtains a means of calculating the quantity of heat evolved during the reciprocal transformations from one variety into another.

New Acetylenic Acids.—Ch. Moureu and R. Delange.—Up to the present, only a small number of the acetylenic acids, $R-C\equiv C-CO_2H$ have been prepared, and their chemical history is very incomplete, owing no doubt to the difficulty of their preparation. In order to investigate the properties of this series of acids, the author prepares a number of them, including many new ones, by the following method:—Carbonic anhydride is fixed on to the sodium derivative of the acetylenic hydrocarbon, $R-C\equiv CNa$. In this manner ethers of the acids can be obtained by treating the same sodium derivatives with chlorocarbonic ethers. The following is a list of acids prepared:—

Propylpropiolic acid, $CH_3-CH_2-CH_2-C\equiv C-CO_2H$.
Isopropylpropiolic acid, $(CH_3)_2CH-C\equiv C-CO_2H$.
Butylpropiolic acid, $CH_3-CH_2-CH_2-CH_2-C\equiv C-CO_2H$.
Trimethyltetrolic acid, $(CH_3)_3C-C\equiv C-CO_2H$.
Amylpropiolic acid, $CH_3-(CH_2)_4-C\equiv C-CO_2H$.
Isoamylpropiolic acid, $(CH_3)_2CH-CH_2-CH_2C\equiv C-CO_2H$.
Hexylpropiolic acid, $CH_3-(CH_2)_5-C\equiv C-CO_2H$.
Isohexylpropiolic, $(CH_3)_2CH-CH_2-CH_2-CH_2-C\equiv C-CO_2H$.
Heptylpropiolic, $CH_3-(CH_2)_6-C\equiv C-CO_2H$.
Nonylpropiolic, $CH_3-(CH_2)_8-C\equiv C-CO_2H$.

Paraethylbenzoic Aldehyde.—H. Fournier.—*p*-Ethylbenzoic aldehyde, $C_6H_4{<}^{C_2H_5\ (1)}_{CHO\ (4)}$, can be prepared by various methods. The author makes a careful preparation in order to fix the constitution of the acid. The substance is heated with concentrated sulphuric acid and precipitated by water. Paraethylbenzoic acid separates, fusing at 113°. After this, the acid fusible at 71° separates, which is paraethylbenzeneketocarbonic acid, $C_6H_4{<}^{C_2H_5}_{COCO_2H}$.

MISCELLANEOUS.

"The Machinery Users' Journal," Vol. I., No. 1.—We have received an advance copy of this new journal, which is just making its appearance. It appears to be of rather a political character, inasmuch as it proposes to keep a close watch upon proceedings in Parliament, and will advise its readers when it is necessary to bring pressure upon the Government, or to lay their views before Committees of either House. Proposals of the Government in respect of taxation, private bill legislation, attempts to still further regulate and control industry, will, in particular, be carefully examined. The journal will not concern itself with subjects which are already adequately dealt with in other periodicals or trade organs, but reviewing all the complex conditions which govern industry in a modern State, it will advise its readers, month by

month, what steps they should take to safeguard or advance their interests. Among the questions it is proposed to consider we may mention the pollution of rivers, rating of machinery, disposal of trade effluents, water supplies, municipal trading, labour organisations, &c., and the journal will seek rather to influence than to merely record events.

The Paper Trade Directory of Great Britain for 1903.—In this Directory will be found the addresses, not only of those who produce paper in the ordinary acceptance of the word, but also of those who manufacture paper-boards for various building purposes, both waterproof and fireproof; paper barrels, kegs and drums; asbestos paper and boards; imitation leather papers and boards; and, we are sorry to see, insoles and other articles for the boot and shoe trade. The book is published at the offices of *Paper Making*, and is compiled and edited by the editor of that journal.

The Roasting of Fluorised Blendes.—E. Prost and E. Lecoq.—On account of its attacking the crucibles, the fluorine contained in blende is very inconvenient in the manufacture of zinc. The roasting of the blende gets rid of a part of it, and it is important to find out under what conditions this loss is at its maximum. When we roast one of these minerals in a current of air, and collect the products of the roasting in water, we observe the production of gelatinous silica, indicating the presence of fluoride of silicon. From comparative assays made on different samples, more or less rich in silica or in fluorine, we see that up to a certain point the silica helps the removal of the fluorine. On the other hand, the heating of fluorine, mixed with oxide of lead, zinc, or iron, does not give rise to any evolution of fluorine. By calcining fluorised minerals in a current of steam we probably obtain the disengagement of a part of the fluorine in the form of hydrofluoric acid.—*Bull. Assoc. Belge Chim.*, vol. xv., No. 2, p. 99.

Action of Nitrate of Copper on Benzene.—N. Vassilief.—The author used very pure benzene free from thiophene and nitrate of copper, $Cu(NO_3)_2.3H_2O$. These two bodies react, one on the other, as soon as the temperature reaches 100°, but the reaction is very slow at first; it is much better to heat in sealed tubes at 170—190° for twelve or eighteen hours. The products of the reaction are numerous; the author has detected, up to the present, picric acid, benzoic acid, and an acid having the composition $C_nO_{2n}H_{2n-2}$; but there are still other compounds not yet examined. At the end of the operation we find in the tubes a lower oily layer, and above that an aqueous layer containing insoluble matters; these latter consist of a basic nitrate of copper, and a salt of copper with the acid $C_nH_{2n-2}O_{2n}$; these three salts are separated with nitric acid of 1·2 density, which dissolves the first and does not affect the second; the third one, placed in suspension in water, is decomposed by sulphuretted hydrogen, and the solution concentrated on the water-bath; at the ordinary temperature it deposits the crystallised acid. This body is very soluble in water, less so in alcohol, and very slightly in ether. In open tubes it does not melt with heat, but decomposes slowly; in sealed tubes it melts at 98–100°, but with partial decomposition, as a pressure is observed due to carbonic acid. The copper salt of this acid is a greenish powder; the silver salt, which curdles as soon as it is precipitated, changes into a yellowish white powder, and detonates when heated; they are both stable with mineral acids, especially hydrochloric and nitric. The acid, heated with hydrochloric acid and alcohol, gives oxalic ether. It is certainly not oxalic acid, for its salts differ from the oxalates, especially those of ammonia and phenylhydrazine; this latter is completely insoluble in water, and only slightly soluble in boiling alcohol; it melts at 175—176° with decomposition. Neither is the acid in question dioxymalonic acid or dioxysuccinic; in fact, it has not been identified with any known acid; the author is continuing its examination.—*Journ. Soc. Phys. Chim. R.*, vol xxxiv., p. 33.

MEETINGS FOR THE WEEK.

TUESDAY, 31st.—Royal Institution, 5. "Great Problems in Astronomy," by Sir Robert Ball, F.R.S.
—— Society of Arts, 4.30. "British North Borneo," by Henry Walker, Commissioner of Lands, British North Borneo.
WEDNESDAY, April 1st.—Society of Arts, 8. "Application of Polyphase Motors to the Electrical Driving of Workshops and Factories," by Alfred C. Eborall, M.I.E.E.
THURSDAY, 2nd.—Royal Institution, 5. "Society during the Commonwealth and Protectorate," by Charles Harding Firth, M.A.
—— Chemical, 8. "On the Absorption Spectra of Nitric Acid in various States of Concentration," by W. N. Hartley. "The Dioximes of Camphorquinone and other Derivatives of *iso*-Nitrosocamphor," by M. O. Forster. "Salts of a Mercaptoid Isomeric Form of Thioallophanic Acid, and a New Synthesis of Iminocarbaminethioalkyls," by A. E. Dixon. "Discoloured Rain," by E. G. Clayton. "Derivatives of *o*-Aminobenzophenone and *p*-Aminobenzophenone," by F. D. Chattaway.
FRIDAY, 3rd.—Royal Institution, 9. "Drops and Surface Tension." by Lord Rayleigh, F.R.S., &c.
SATURDAY, 4th.—Royal Institution, 3. "Light—its Origin and Nature," by Lord Rayleigh, F.R.S., &c.

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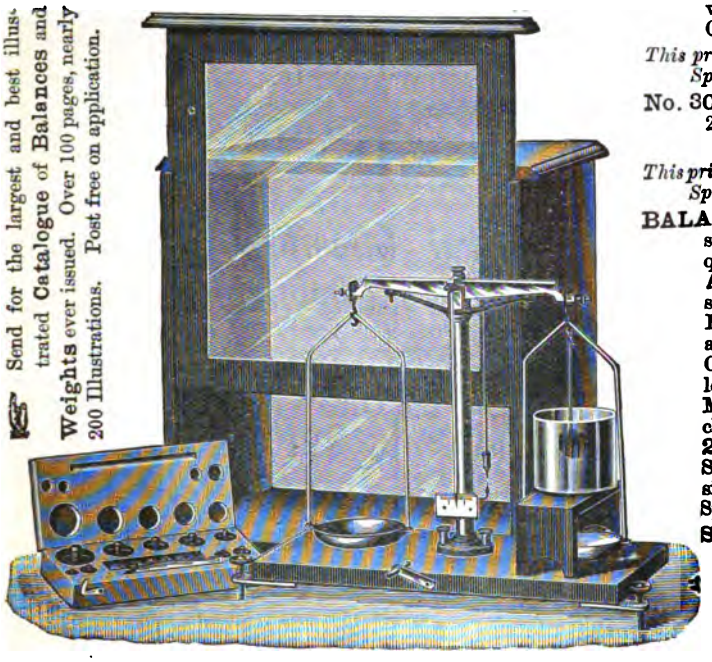

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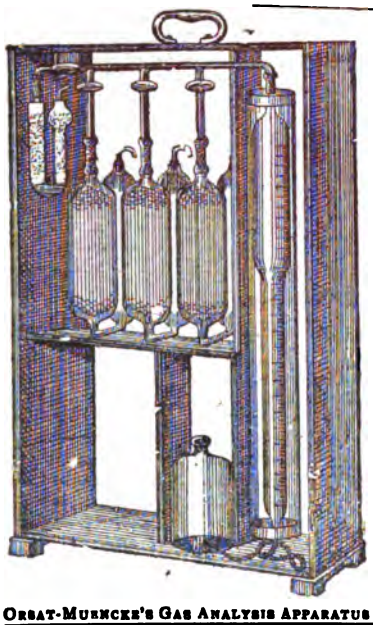

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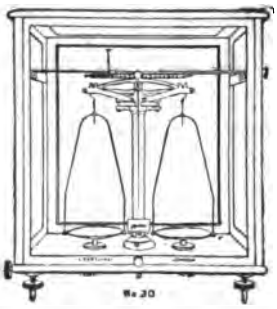

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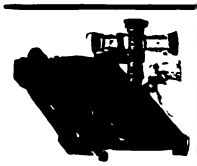

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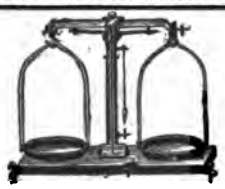

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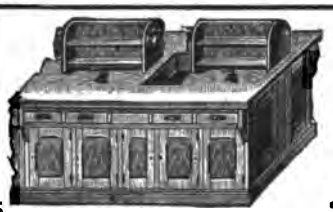

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THE EMANATIONS OF RADIUM.*

By Sir WILLIAM CROOKES, F.R.S.

A SOLUTION of almost pure radium nitrate which had been used for spectrographic work, was evaporated to dryness in a dish, and the crystalline residue examined in a dark room. It was feebly luminous.

A screen of platinocyanide of barium brought near the residue glowed with a green light, the intensity varying with the distance separating them. The phosphorescence disappeared as soon as the screen was removed from the influence of the radium.

A screen of Sidot's hexagonal blende (zinc sulphide), said to be useful for detecting polonium radiations, was almost as luminous as the platinocyanide screen in presence of radium, but there was more residual phosphorescence, lasting from a few minutes to half an hour or more according to the strength and duration of the initial excitement.

The persistence of radio-activity on glass vessels which have contained radium is remarkable. Filters, beakers, and dishes used in the laboratory for operations with radium, after having been washed in the usual way, remain radio-active; a piece of blende screen held inside the beaker or other vessel immediately glowing with the presence of radium.

The blende screen is sensitive to mechanical shocks. A tap with the tip of a pen-knife will produce a sudden spark of light, and a scratch with the blade will show itself as an evanescent luminous line.

A diamond crystal brought near the radium nitrate glowed with a pale bluish-green light, as it would in a "Radiant Matter" tube under the influence of cathodic bombardment. On removing the diamond from the radium it ceased to glow, but, when laid on the sensitive screen, it produced phosphorescence beneath which lasted some minutes.

During these manipulations the diamond accidentally touched the radium nitrate in the dish, and thus a few imperceptible grains of the radium salt got on to the zinc sulphide screen. The surface was immediately dotted about with brilliant specks of green light, some being a millimetre or more across, although the inducing particles were too small to be detected on the white screen when examined by daylight.

In a dark room, under a microscope with a ⅔-inch objective, each luminous spot is seen to have a dull centre surrounded by a luminous halo extending for some distance around. The dark centre itself appears to shoot out light at intervals in different directions. Outside the halo the dark surface of the screen scintillates with sparks of light. No two flashes succeed one another on the same spot, but are scattered over the surface, coming and going instantaneously, no movement of translation being seen.

The scintillations are somewhat better seen with a pocket lens magnifying about 20 diameters. They are less visible on the barium platinocyanide than on the zinc sulphide screen.

A powerful electro-magnet has no apparent effect on the scintillations, which appear quite unaffected when the current is made or broken, the screen being close to the poles, and arranged axially or equatorially.

A solid piece of radium nitrate is slowly brought near the screen. The general phosphorescence of the screen as visible to the naked eye varies according to the distance of the radium from it. On now examining the surface with the pocket lens, the radium being far off and the screen faintly luminous, the scintillating spots are sparsely scattered over the surface. On bringing the radium nearer the screen the scintillations become more numerous and brighter, until when close together the flashes follow each other so quickly that the surface looks like a turbulent luminous sea. When the scintillating points are few there is no residual phosphorescence to be seen, and the sparks succeeding each other appear like stars on a black sky. When, however, the bombardment exceeds a certain intensity, the residual phosphorescent glow spreads over the screen, without, however, interfering with the scintillations.

If the end of a platinum wire which has been dipped in a solution of radium nitrate and dried is brought near the screen, the scintillations become very numerous and energetic, and cease immediately the wire is removed. If, however, the end of the wire touches the screen, a luminous spot is produced which then becomes a centre of activity, and the screen remains alive with scintillations in the neighbourhood of the spot for many weeks afterwards.

"Polonium" basic nitrate produces a similar effect on the screen, but the scintillations are not so numerous.

Microscopic glass, very thin aluminium foil, and thin mica do not stop the general luminosity of the screen from the X-rays, but arrest the scintillations.

I could detect no variation in the scintillations when a rapid blast of air was blown between the screen and the radium salt.

A beam of X-rays from an active tube was passed through a hole in a lead plate on to a blende screen. A luminous spot was produced on the screen, but I could detect no scintillations, only a smooth, uniform phosphorescence. A piece of radium salt brought near gave the scintillations as usual, superposed on the fainter phosphorescence caused by the X-rays, and they were not interfered with in any degree by the presence of X-rays falling on the same spot.

During these experiments the fingers soon become soiled with radium, and produce phosphorescence when brought near the screen. On turning the lens to the, apparently, uniformly lighted edge of the screen close to the finger, the scintillations are seen to be closer and more numerous; what to the naked eye appears like a uniform "milky way," under the lens is a multitude of stellar points, flashing over the whole surface. A clean finger does not show any effect, but a touch with a soiled finger is sufficient to confer on it the property. Washing the fingers stops their action.

It was of interest to see if rarefying the air would have any effect on the scintillations. A blende screen was fixed near a flat glass window in a vacuum tube, and a piece of radium salt was attached to an iron rocker, so that the movement of an outside magnet would either bring the radium opposite the screen or draw it away altogether. A microscope gave a good image of the surface of the screen, and in a dark room the scintillations were well seen. No particular difference was observed in a high vacuum—indeed, if anything, the sparks appeared a trifle brighter and sharper in air than *in vacuo*. A duplicate apparatus in air was put close to the one in the vacuum tube, so that the eye could pass rapidly from one to the other, and it was so adjusted that the scintillations were about equal, when each was in air. The vacuum apparatus was now exhausted to a very high point, and the appearance on each screen was noticed. Here, again, I thought the sparks in the vacuum were not quite so bright as in air, and on breaking the capillary tube of the pump and observing as the air entered, the same impression was left on my mind; but the differences, if any, are very minute, and are scarcely greater than might arise from errors of observation.

It is difficult to form an estimate of the number of flashes of light per second. But with the radium at about five centims. off the screen they are barely detectable,

* A Paper read before the Royal Society, March 19, 1903.

not being more than one or two per second. As the distance of the radium diminishes the flashes become more frequent, until at one or two centims. they are too numerous to count.

On bringing alternately a Sidot's blende screen and one of barium platinocyanide face downwards near a dish of "polonium" sub-nitrate, each became luminous, the blende screen being very little brighter of the two. On testing the two screens over a crucible containing dry radium nitrate, both glowed; in this case the blende screen being much the brighter. Examined with a lens, the light of the blende screen was seen to consist of a mass of scintillations, while that of the platinocyanide screen was a uniform glow, on which the scintillations were much less apparent.

The screens were now turned face upwards, so that emanations from the active bodies would have to pass through the thickness of card before reaching the sensitive surface. Placed over the "polonium" neither screen showed any light. Over the radium the platinocyanide screen showed a very luminous disc, corresponding with the opening of the crucible, but the blende disc remained quite dark.

It therefore appears that practically the whole of the luminosity on the blende screen, whether due to radium or "polonium," is occasioned by emanations which will not penetrate card. These are the emanations which cause the scintillations, and the reason why they are distinct on the blende and feeble on the platinocyanide screen, is that with the latter the sparks are seen on a luminous ground of general phosphorescence which renders the eye less able to see the scintillations.

Considering how coarse-grained the structure of matter must be to particles forming the emanations from radium, I cannot imagine that their relative penetrative powers depend on difference of size. I attribute the arrest of the scintillating particles to their electrical character, and to the ready way in which they are attracted by the coarser atoms or molecules of matter. I have shown that radium emanations cohere to almost everything with which they come into contact. Bismuth,* lead, platinum, thorium, uranium, elements of high atomic weight and density, possess this attraction in a high degree, and only lose the emanations very slowly, giving rise to what is known as "induced radio-activity." The emanations so absorbed from radium by bismuth, platinum, and probably other bodies, retain the property of producing scintillations on a blende screen, and are non-penetrating.

It seems probable that in these phenomena we are actually witnessing the bombardment of the screen by the electrons† hurled off by radium with a velocity of the order of that of light; each scintillation rendering visible the impact of an electron on the screen. Although, at present, I have not been able to form even a rough approximation to the number of electrons hitting the screen in a given time, it is evident that this is not of an order of magnitude inconceivably great. Each electron is rendered apparent only by the enormous extent of lateral disturbance produced by its impact on the sensitive surface, just as individual drops of rain falling on a still pool are not seen as such, but by reason of the splash they make on impact, and the ripples and waves they produce in ever-widening circles.

Announcement.—Mr. Bertram Blount announces that owing to the death of his late partner, Mr. W. Harry Stanger, the firm of Stanger and Blount is dissolved. The business of the late firm is being temporarily conducted at 2, Broadway, Westminster, but at an early date Mr. Blount will remove to other premises in Westminster.

* I have been quite unable to detect any lines but those of bismuth (and of known impurities) in the spectrum of the strongest and most active "polonium" salt I have been able to procure.

† Radiant matter, satellites, corpuscles, nuclei; whatever they are, they act like material masses.

THE MYSTERY OF RADIUM.

By Sir WILLIAM CROOKES, F.R.S.

The following letter appeared in *The Times* of March 26th:—

Sir,—In the presence of a mystery like that of Radium any reasonable attempt at explanation will be welcome, so I will ask your permission to revive a hypothesis I ventured to submit to the British Association in my Presidential Address in 1898. Speaking of the radio-active bodies then just discovered by M. and Mdme. Curie, I drew attention to the large amount of energy locked up in the molecular motions of quiescent air at ordinary pressure and temperature, which, according to some calculations by Dr. Johnstone Stoney, amounts to about 140,000 foot-pounds in each cubic yard of air; and I conjectured that radio-active bodies of high atomic weight might draw upon this store of energy in somewhat the same manner as Maxwell imagined when he invented his celebrated "Demons" to explain a similar problem. I said it was not difficult so to modify this hypothesis as to reduce it to the level of an inflexible law, and thus bring it within the ken of a philosopher in search of a new tool. I suggested that the atomic structure of radio-active bodies was such as to enable them to throw off the slow-moving molecules of the air with little exchange of energy, while the quick-moving missiles would be arrested, with their energy reduced and that of the target correspondingly increased. (A similar sifting of the swift-moving molecules is common enough, and is effected by liquids whenever they evaporate into free air). The energy thus gained by the radio-active body would raise its temperature, while the surrounding air would get cooler. I suggested that the energy thus gained by the radio-active body was employed partly in dissociating some of the gaseous molecules (or in inducing some other condition which would have the effect of rendering the neighbouring air a conductor of electricity) and partly in originating undulations through the ether, which, as they take their rise in phenomena so disconnected as the impacts of molecules, must furnish a large contingent of Stokesian pulses of short wave-length. The shortness in the case of these waves appears to approach, without attaining, the extreme shortness of ordinary Röntgen rays.

Although the fact of emission of heat by Radium is in itself sufficiently remarkable, this heat is probably only a small portion of the energy Radium is constantly sending into space. It is at the same time hurling off material particles which reveal their impact on a screen by luminous scintillations. Stop these by a glass or mica screen and torrents of Röntgen rays still pour out from a few milligrms. of Radium salt, in quantity to exhibit to a company all the phenomena of Röntgen rays, and with energy enough to produce a nasty blister on the flesh, if kept near it for an hour.

In conclusion, if it is not too much trespassing on your space, I should like to express the great admiration which I have, in common with all English men of science, at the brilliant discovery of Radium, and its unique properties—the crowning point of the long and painstaking series of researches on radio-active bodies undertaken by Professor Curie and his talented coadjutor, Mdme. Curie.

I remain, Sir, your obedient servant,

WILLIAM CROOKES.

Society of Arts.—The following are the arrangements for the Wednesday evening meetings of the Society of Arts after Easter:—April 22.—"Modern Bee Keeping," by Walter Francis Reid, F.C.S. April 29.—"Automatic Wagon Couplings," by T. A. Brockelbank. May 6.—"The Construction of Maps and Charts," by G. T. Morrison. May 13.—"Preservation of Big Game in Africa," by E. North Buxton. May 20.—"Fencing as an Art and an Historic Sport," by Egerton Castle, M.A.

HEAT EVOLVED BY RADIUM SALTS.

By P. CURIE and A. LABORDE.

We have already proved that radium salts give out heat continuously. A thermo-electric couple, in which one junction is surrounded by radiferous barium chloride and the other by pure barium chloride, registers a difference between the temperatures of the two bodies.

We made the experiment with two small identical bulbs; putting in one of them 1 grm. of radiferous barium chloride containing about one-sixth of its weight of radium chloride, and in the other 1 grm. of pure barium chloride. The junctions of the thermo-electric couple were placed in the centre of each cell respectively surrounded by the chloride. The cells were isolated in the air in the centre of two identical vessels, themselves situated in a third which was calorifically isolated, and in which the temperature was practically uniform. Variation in the surrounding temperature under these conditions affects both junctions in the same way, and has no influence on the reading of the couple.

We have by this apparatus proved that there is a difference of temperature of 1·5° C. between the radiferous barium chloride and pure barium chloride, the radiferous salt having the higher temperature. As a check, we repeated the experiment under the same conditions with two cells, both containing pure barium chloride. The differences of temperature observed in this case were only of the order of greatness of $\frac{1}{100}$th of a degree.

We next endeavoured to evaluate the heat evolved by radium in a given time quantitatively.

In order to do this, the heat thus evolved is compared with that evolved by an electric current of known intensity flowing through a wire of known resistance. A bulb containing radium was enclosed in a block of metal, to which it communicated its heat. One of the junctions of the thermo-electric couple was placed in a cavity hollowed out of the metal, the other junction in a second similar block which contained no radium. When contact is established, the block receives from the radium in a given time as much heat as it loses by conduction and by radiation towards the outside. The couple therefore registered a certain difference of temperature between the two blocks.

When the experiment was finished, the bulb containing the radium was removed, and for it substituted a bulb in which was coiled a fine wire of platinum-iridium, which was heated by a current of electricity. The intensity of the current was varied until the difference of temperature between the two blocks was the same as in the preceding experiment. The heat evolved by the radium in the first experiment is thus equal to that evolved in the same time by the current in the second experiment. This latter quantity is easy to calculate.

We have further evaluated the heat evolved by radium by direct measurements with the Bunsen calorimeter.

Before making the experiment, it was first necessary to ascertain that the level of the mercury in the stem of the calorimeter remained absolutely steady. The bulb containing the radium was kept during this time in a tube maintained at zero by melting ice. At a given moment, the bulb was introduced into the calorimeter, and it was found that the mercury in the stem was displaced with a perfectly uniform velocity (2·5 c.m. per hour, for example, with the quantities mentioned above). When the bulb containing the radium was removed, the mercury at once remained stationary. The grm. of radiferous barium chloride with which the majority of these experiments were performed evolved about 14 small calories per hour, but its composition was not exactly known. According to its radio-activity, it should contain about one-sixth of its weight of pure radium chloride. Further experiments were made with a specimen of 0·08 grm. of pure radium chloride. Measurements made by both methods lead to results which are of the same order of greatness without being absolutely concordant.

In our first researches we are proposing only to demonstrate in an indisputable manner the existence of this evolved heat by working under varying conditions and giving the order of greatness of the phenomenon.

One grm. of radium evolves in one hour a quantity of heat which is of the order of 100 small calories per hour.

One grm. atom of radium (225 gr.) evolves during one hour 22,500 calories, a number comparable with that of the heat evolved by the combustion of 1 grm. atom of hydrogen.

The continuous evolution of such a quantity of heat cannot be explained by ordinary chemical transformation. If we look for the origin of the heat in an internal transformation, this transformation must be of a very profound nature, and must be due to a modification of the atom of radium itself. However, such a transformation, if it exists, takes place with extreme slowness. Indeed, the properties of radium show no variation after several years, and Demarçay observed no difference in the spectrum of the same specimen of radium chloride during experiments made at intervals of five months. If therefore the above hypothesis is correct, the energy brought into play during the transformation of the atoms must be extraordinarily great.

The hypothesis of a continuous modification of the atom is not the only one compatible with the evolution of heat by radium. This evolution can also be explained by supposing that radium is capable of utilising an external energy of unknown nature.—*Comptes Rendus*, cxxxvi., p. 673.

AN ATTEMPT TO ESTIMATE THE RELATIVE AMOUNTS OF KRYPTON AND OF XENON IN ATMOSPHERIC AIR.*

By Sir WILLIAM RAMSAY, K.C.B., F.R.S.

When Dr. Travers and I isolated krypton and xenon from air, we had very little idea of the total amount of liquid air from which, by its evaporation, these gases had been obtained. And we were then more concerned with the isolation of the gases in a pure state than in the determination of the proportion in which they exist in the atmosphere. Our knowledge of the composition of the air, however, is not complete until the total yield of krypton, xenon, neon, and helium has been determined. An estimation of the last two is being undertaken by Dr. Travers.

In our experiments on these gases ("Argon and its Companions," *Phil. Trans.*, vol. cxcvii., A, pp. 47—89; abstract in Chemical News, 1900, vol. lxxxii., p. 257) we did not measure the total quantity of air evaporated. We used liquid air for various purposes, and for some months we collected the dregs, allowing them to evaporate into a large gas holder. We guessed (but it was only the roughest estimate) that we had accumulated in this manner the residues from about 30 litres of liquid air; and on this assumption we thought the following estimates not improbable:—Helium, 1—2 parts per million of gaseous air; neon, 1 per 100,000; krypton, 1 per million; xenon, 1 per 20,000,000. But they rested on a very insecure foundation of fact.

The first preliminary experiment was made to ascertain how much of the air which passes through the Hampson liquefier is converted into liquid. The results, however, were inaccurate, and I would rather cite the conclusions given by later experiments on a much larger scale. The compressor was run for several hours every morning and afternoon during six and a half days; the liquefied air was weighed after each run; and the escaping air passed through a large gas-meter, where its volume was registered. The air escaping had a somewhat lower density than ordinary air, owing to the partial removal of

* A Paper read before the Royal Society, March 26, 1903.

oxygen and argon; but the experiments were not sufficiently accurate to make it worth while to take this into account. The volumes given are, however, corrected for alterations of pressure and temperature. In all, 179·7 kilos. of gaseous air passed the meter, and 10·8 kilos. of liquid air were collected. During the collection, about 6 per cent of the liquid air evaporates; adding this, 11·4 kilos. must have been the total weight of air liquefied. The total weight of air taken in by the compressor, therefore, and delivered to the liquefier was consequently 179·7+11·4=191·1 kilos., and the percentage liquefied a little under 6 per cent. The number may be taken without sensible error as 6 per cent liquefaction.

During these runs the pressure was kept at 190 atmospheres; and the delivery of air through the escape valve of the liquefier remained fairly uniform. Separate readings, taken at different times, of the amount of air passing the meter gave 0·244, 0·230, 0·258, 0·261, 0·248, and 0·239 kilos. per minute; these figures testify to fairly uniform working.

It was of interest to see whether argon concentrated itself in the liquefied portion of the air, or whether most of it escaped as gas. The boiling-points of the principal atmospheric gases are on the absolute scale:—Nitrogen, 77·54°; argon, 86·90°; oxygen, 90·5°; the differences are 9·36° and 3·6° respectively; it was therefore to be expected that the argon would concentrate in the liquid.

An experiment was therefore made in which 12·73 grms. of freshly collected liquid air was allowed to boil in a double-walled vacuum tube, and the gases were led directly over metallic copper and magnesium lime; the resulting argon measured 165 c.c. at 0° and 760 m.m. pressure. The weight of this argon was 0·2943 grm., or from 1 grm. of liquid air, 0·02312 grm. Now 1 grm. of atmospheric air contains 0·0129 grm. of argon; hence the process of liquefaction nearly doubles the content of argon in the air. It is, therefore, very advantageous to prepare argon from air which has been liquefied.

Acting on this suggestion, it appeared *à fortiori* probable that if the percentage of argon in air were doubled by liquefaction, the krypton and the xenon would be practically wholly removed and liquefied. And by submitting liquefied air to a second liquefaction, by boiling it off through the compressor, it appeared to hold that a concentration of the krypton and xenon would result, and that they would be found wholly in the liquefied portion. An experiment was therefore begun in which about 100 kilos. of gaseous air were passed through the liquefier; the liquefied portion, amounting to about 6 kilos., was again passed through the liquefier, somewhat added to by gaseous air, drawn in by the compressor. By an unfortunate accident, however, nine-tenths of the air collected during the second liquefaction was lost; and the amount of xenon and krypton in the remaining tenth, representing about 10 kilos. of gaseous air, did not appear to justify repetition of the troublesome experiment. I have no doubt, however, that had these experiments not had for their object the determination of quantity, but only the preparation of krypton and xenon, they would have effected the separation well.

The liquid air, resulting from the liquefaction of 6 per cent of 191·1 kilos. of gaseous air, was sucked, several litres at a time, into a large glass balloon of about 5 litres capacity, fitted with an indiarubber cork, through which a wide tube passed, connected with a double-acting Fluess pump, driven by an electric motor. Through another hole in the cork there passed a syphon which could be closed by means of a brass stopcock; this tube served to admit liquid air to the balloon. A manometer was also connected with the interior of the flask so as to register the pressure under which the liquid air was boiling. The air boiled at a pressure of about 250 m.m., corresponding to a temperature of about −195°. The boiling was quite quiet, without bumping; it was sometimes necessary to warm the balloon gently in order to accelerate the evaporation. The object of distilling at a low temperature was to lower the vapour-pressure of the krypton and xenon in the liquid air, and so to lessen, or in great part to prevent, their evaporation. The total liquid air was thus reduced to about 200 c.c.

The balloon containing this air was coupled with a large iron tube, holding about 20 kilos. of reduced copper heated to bright redness. The liquid air residue, naturally, consisted largely of oxygen, for the more volatile nitrogen had in great part evaporated. After passing over the copper the volume of gas was about 50 litres.

It may be contended that during the evaporation of the air, even at −195°, a large portion of the krypton and xenon may pass away as gas. It is not possible to estimate the amount lost in this manner; but at −195°, the vapour-pressure of krypton is 2·8 m.m., and that of xenon 0·02 m.m. These figures have been arrived at in the following manner:—Relying on the vapour-pressures of mercury by Ramsay and Young, given in the *Trans. Chem. Soc.*, 1886, p. 50, and on the measurements made by Ramsay and Travers (*Phil. Trans.*, 1901, p. 72) of the vapour pressures of krypton and xenon, ratios were found between the absolute temperatures of mercury on the one hand, and of krypton and xenon respectively on the other, between the pressures 300 and 3000 m.m., with two additional data—the temperatures of krypton corresponding to pressures of 9 and of 17·4 m.m. They are as follows:—

Pressures (m.m.).	Temp. of mercury. Degrees absolute.	Temp. of krypton. Degrees absolute.	Ratios.	Temp. of xenon. Degrees absolute.	Ratios.
9·0	454·8°	94·2°	0·1851	—	—
300	582·2	110·4	0·1897	148·9°	0·2257
400	596·4	113·8	0·1909	153·2	0·2569
500	609·0	116·1	0·1907	156·8	0·2575
600	617·9	118·35	0·1915	159·7	0·2583
700	626·5	120·2	0·1918	162·0	0·2586
760	631·2	121·3	0·1922	163·9	0·2597
3000	726·8	142·2	0·1957	192·4	0·2647

These ratios were mapped against the absolute temperatures of mercury, and were found, as usual, to give straight lines. The lines were extrapolated to lower temperatures, and the vapour-pressures required were calculated from the extrapolated curves.

The portion of interest is given in the following table:—

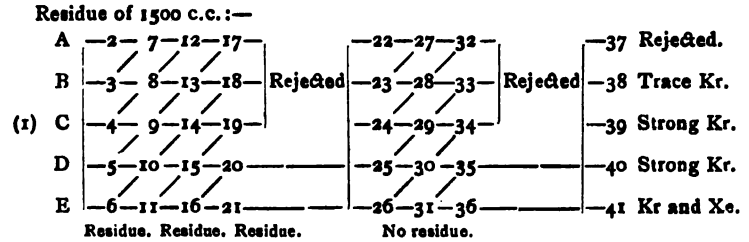
Temperature. °C.	Vapour-pressure of krypton. M.m.	Vapour-pressure of xenon. M.m.
−205	0·27	0·0005
−200	0·97	0·007
−195	2·8	0·02
−190	7·5	0·04
−188·8	9·0	0·11
−182·4	17·4	0·17

The last two data for krypton are the results of direct measurement. It may be mentioned here that the melting-point of krypton is about −169°, and that of xenon −140°; and the boiling-points at atmospheric pressure are—krypton −151·7°, and xenon −109·1°.

The nitrogen was removed from the 50 litres of gas by passing it over red-hot magnesium-lime mixture. The resulting crude argon measured 12·5 litres at 16° and 770 m.m.; its weight is calculated from its known density as 21·3 grms.

This argon was liquefied in a bulb immersed in liquid air, boiling under reduced pressure, so as to reduce the vapour-pressure of the krypton and xenon; and the major part was re-transferred through a Töpler pump to the gas-holder from which it had passed to the liquefying bulb. About 1500 c.c. of the last portions to distil away were collected in five mercury gas-holders, each of a capacity of 300 c.c. The argon was now methodically fractionated according to the accompanying scheme.

The 1200 c.c. numbered (1) was, as described, distributed in five gas-holders. The contents of the first—the one first



filled is termed A—was liquefied, and half the amount replaced in gas-holder A. The contents of B were liquefied, and A was filled, by allowing the liquid argon to evaporate under reduced pressure. The contents of C were liquefied along with what remained of B; and B was filled in like manner. D was liquefied, and C filled; and, finally, E and D filled. The residue in the liquefying bulb, which evaporated very slowly after the argon had boiled away, was removed through the pump, and collected in a tube over mercury. The contents of A, B, C, D, and E are labelled 2, 3, 4, 5, and 6. The process was repeated; and with this explanation the scheme can be understood.

No. 41 was mixed with the residues, which contained much xenon, along with krypton. Nos. 38, 39, and 40 were mixed, and the fractionation continued in a small apparatus. The gases were now sparked with oxygen over soda, so as to remove traces of air; for the operations had now to be conducted with great care, and the spectra of the two samples showed traces of nitrogen. After withdrawal of oxygen from both sets of gas, by means of phosphorus, the krypton mixture was fractionated into three portions; 42, containing much argon; 43, rich in krypton; and 44, a non-volatile residue. The xenon residues, 41, were also solidified with liquid air, and placed for a few seconds in connection with the vacuum of the Töpler pump. The gas which was pumped off was added to 43, and the residue to 44. The bulb was now left for a quarter of an hour, so that equilibrium might be restored, and the stopcock opened a second time. A bubble or two was removed with the pump. On making communication with the pump a third time, no gas escaped; and this is not remarkable, for the vapour pressure of xenon is little over 0·1 m.m. at that temperature. It was therefore assumed that the final residue was pure xenon; and, indeed, its spectrum showed no trace of the krypton lines. And it may also be taken for granted that very little xenon was added to No. 43. The densities of Nos. 42 and 43 were determined; and from the known densities of argon and krypton, their relative proportions were calculated.

The density of 42 was found to be 21·31, corresponding to the percentage composition, argon, 93·5 per cent; krypton, 6·5 per cent; the density of 43 was 39·43, implying a mixture of argon, 6·6 per cent, krypton, 93·4 per cent. The volume of No. 42, reduced to 0° and 760, was 220 c.c.; it therefore contained 1·43 c.c. of krypton; that of No. 43 was 6·5 c.c., and it contained 6·1 c.c. of krypton. The total volume of krypton was therefore 7·5 c.c., and its weight 0·0028 grm.; the volume of the xenon, reduced to 0° and 760 was 0·87 c.c., and its calculated weight 0·0005 grm.

These results are reproduced in the accompanying tabular statement (see next column).

As before remarked, it is not maintained that all the krypton and all the xenon have been separated; it is likely, however, that the separation of the xenon was more perfect than that of the krypton. The results are merely brought forward as the result of a careful experiment to quantitatively isolate these gases.

I have to express my cordial thanks to Mr. E. C. C. Baly and to Mr. Inglis for aid in carrying out part of these operations.

As a quantity of pure krypton, sufficient for determination of density, had been collected, occasion was taken to re-determine the density of that gas. It was submitted to careful fractionation; a considerable portion was rejected as possibly containing argon, and the dregs were set aside as possibly having contained xenon. The substance weighed had a low vapour pressure—about 15 m.m. at the temperature of the liquid air used in fractionating. The separation of the lighter and heavier portions was repeated four times, the density having been determined on each occasion, with only small differences. Finally, a very careful determination of density was carried out, with the following results:—

Volume of density-bulb	7·268 c.c.
Temperature	15·57° C.
Pressure on gas, corrected	754·0 m.m.
Weight	0·02488 grm.
Hence density, compared with O = 16	40·81

Previous determinations with two samples of gas, one fractionated from argon, the other fractionated from xenon, gave 40·82 and 40·73 respectively as the density. The result given above is in perfect concordance with these figures. The chief cause of error is in the weight; I think it would be fair to regard two units in the fifth place as the limit of error, which gives a possible divergence of about 1 part in 1200.

The atomic weight of krypton would accordingly be 81·62; the mean of former determinations is 81·28. This is in accordance with its position in the periodic table, which lies between bromine, 80, and rubidium, 85.

Air passed through liquefier	191·1 kilogrms.
Air liquefied	11·3 kilogrms. = 5·91 p.c.
Argon obtained (11·8 litres at 0° and 760)	21·3 grms.
Argon per cent of gaseous air	0·0118; of liquid air, 0·1885
Total krypton obtained	0·0028 grm.
Total xenon obtained	0·0005 grm.
Percentage krypton in gaseous air	0·000014 by weight
Percentage xenon in gaseous air	0·0000026 by weight

Krypton equal to 1 part by weight in about 7 millions of air; by volume, 1 part in 20 millions.

Xenon equal to 1 part by weight in about 40 millions of air; by volume, 1 part in 170 millions.

Oxygen.—There has recently been placed on the market an oxygen generator which is likely to be a great boon to any having an occasional use of a supply of this gas. The apparatus consists essentially of a metal retort heated by a spirit-lamp, a washing-tank, and a gas-bag. Cylinders of compressed chlorate of potash and manganese are supplied for charging the retort, and the whole apparatus is packed up in a strong iron-bound box. There appears to be nothing that can easily get out of order, and a supply of gas can be obtained in a few minutes and maintained in sufficient quantity to supply an ordinary oxy-hydrogen lantern for any reasonable time. The apparatus is manufactured by the International Oxy-generator Syndicate, Ltd., 21, Southampton Row, W.C.

SOME ADDITIONAL REMARKS ON THE CONNECTION BETWEEN METALS AND NON-METALS, AND ITS BEARING ON THE VALENCE THEORY OF HELMHOLTZ AND ON STEREO-CHEMISTRY.

By GEOFFREY MARTIN, B.Sc.(Lond.).

In a previous paper (Chemical News, 1902, lxxxvi., 295) I suggested that a low temperature would transform metals into non-metals. If this suggestion be correct, some extremely remarkable results follow as a consequence.

1. At some temperature above absolute zero all substances recognised as metals at ordinary temperatures would become almost incapable of conducting electricity. Lord Kelvin believes at the absolute zero that all substances are absolute non-conductors of electricity (*Phil. Mag.*, March, 1902).

2. They would also become incapable of conducting heat, since a capacity for conducting heat in general is associated with a capacity for conducting electricity.

It is natural to infer that at the absolute zero to temperature all substances become absolute non-conductors of heat. This result was arrived at (and communicated to the Physical Society) by Mr. Brinkworth and myself towards the end of 1901 as a consequence of the breach of the law of thermal equilibrium at very low temperatures (*vide* Chemical News, 1902, lxxxv., 194). This and some other equally remarkable results of the reasoning contained in that paper will be published later.

3. At these very low temperatures the bodies recognised as metals at ordinary temperatures would lose their metallic lustre, and become in most cases brightly coloured solids; presenting, in fact, an appearance similar to that presented by the non-metals sulphur or iodine at ordinary temperatures.

It must be remembered the colour of metallic substances is completely hidden by their metallic lustre. Yet most of these metals are undoubtedly very vividly coloured bodies.

For example, the vapour of sodium is violet, just as the vapour of iodine is violet. Silver produces a blue vapour. Gold in thin layers transmits a greenish light. In a solid condition, therefore, and in such a state that the effect of their metallic lustre is eliminated, we should expect such substances to appear quite as brightly coloured as solid iodine or sulphur.

3. Since the valency bonds of a metal are of an electro-positive nature, while the valency bonds of a non-metal are of an electro-negative nature; then, if a metal can be transformed into non-metal by simply lowering the temperature sufficiently, it follows that the difference between a negative and positive valency bond lies not in any absolute difference in the nature of the electrons (atoms of electricity), which are supposed to cause the phenomena of valency (Helmholtz, *Journ. Chem. Soc.*, 1881, xxxix., 277), but solely in the difference in the stability with which the electrons are held by the atom.

If these electrons are very firmly held by the atoms (non-metals) they give rise to what are known as negative valency bonds. If feebly held (metals) they give rise to positive valency bonds.

This conclusion is supported by other considerations.

(*a*). Carbon, a non-metal, is tetravalent, and therefore possesses four negative electrons condensed on its surface. Tin, a metal of the same group, possesses four positive electrons, being also tetravalent.

If these valencies were in the two cases caused by two entirely different-in-nature entities (such as positive and negative electrons are often supposed to be), these two sets of valencies should behave quite differently. But this is not the case.

Tin combines with the same radicles as carbon (*e.g.*, Cl, O, CH_3—, C_2H_5—, &c.), and produces corresponding compounds.

Not only is this so, but tin can actually replace optically active carbon in certain bodies and without the compounds losing their optical properties, as Mr. Pope has shown (*Journ. Chem. Soc.*, 1900).

This last case clearly demonstrates that the tin atom can combine with the same radicles as the carbon atom, and in such a manner that the individual radicles are attached to the tin atom in precisely the same way that they were attached to the carbon atom.

So that the four valencies of the tin atom produce precisely the same effect as the corresponding four valencies of carbon.

It is therefore highly improbable that the valencies of tin are produced by a cause diametrically opposite to that which produces the valencies of carbon, as would be the case were the so-called positive and negative electrons of an entirely different nature.

A similar argument applies to other groups of elements (*e.g.*, the N—Bi group), and to the replacement of H by Cl.

(*b*). The more heavily charged with electrons is an atom the greater the mutual repulsion the electrons exert on each other.

An addition of electrons to an atom, therefore, produces the same effect on the stability with which the electrons are held as an increase of temperature. In both cases the negative valencies should tend to become positive, if the positive or negative nature of a valency bond depends only on the degree of stability with which the electron producing that bond is held by the atom. A great many examples can be quoted showing that this actually does take place. In fact, it is a well known empirical generalisation that unsaturated radicles are electro-negative and saturated radicles usually electro-positive in nature. We quote two of the most striking examples.

Iodine.—The valency bond attached to monovalent iodine is strongly electro-negative (*cf.* KI, AgI, &c.). But when two additional electrons are added to the iodine atom the valencies become strongly electro-positive. For example, the residual valence attached to I in the radicle $C_6H_5>I-$ acts in the same way as the valence attached to the thallous atom, Tl— (V. Meyer, *Ber.*, xxv., 205).

Nitrogen.—The valency bonds attached to trivalent nitrogen are strongly electro-negative. For example, the residual valence in in the system $\frac{H}{H}>N-$ can enter into combination with metals, and play the part of the negative valence of the system HO—, as appears manifest from the large number of metallic amido-compounds now known to exist.

But when we endow the nitrogen atom with three additional electrons (as in the system $\frac{Et}{Et}>N-$), the residual valence changes to sharply positive, the residual valence of the radicle Et_4N- being as strongly electro-positive as that attached to an Na or K atom; Et_4N-OH is, in fact, as powerful a base as NaOH. *We thus arrive at the generalisation that one, and only one, kind of electrons cause the phenomena of chemical valence. The electrons can cause an atom to appear either as electro-positive or electro-negative in nature according as they are feebly or firmly held by the atom.* This places us in a position to define the law of the special arrangement of the valence bonds on the surface of the atom. For electrons, being equally charged particles of like sign, repel each other with the same force.

Therefore in the case of a polyvalent spherical atom whereon several electrons are condensed by the attractive power of the material out of which the atom is composed, the mutual repulsion between the electrons will cause them to take up a position of equilibrium on the surface of the sphere such that each is as far removed as

possible from its neighbour, and if possible in a symmetrical position.

Therefore the manner in which the electrons (and, consequently, valency bonds) distribute themselves over the surface of an atom depends only upon the number of electrons, and not at all upon the nature of the material out of which the atom is composed. The problem, therefore of determining the shape of an atom of valency n is reduced to the problem of distributing n points as symmetrically as possible over the surface of a sphere. We infer—

1. The shape of an atom depends only upon its valency. All atoms which possess the same number n of valency bonds have the same shape, provided that there exists only one way of arranging symmetrically these n points over the surface of a sphere.

2. When the valence of an atom changes, its shape also changes, and in a way that depends not at all upon the nature of the atom, but solely upon the final value of its valence.

We have deduced these generalisations by assuming the atoms on which the electrons are condensed are spherical. Even if this is not so, the same results hold approximately true on account of the very great repulsion that electrons are capable of exerting on each other.

The first of the generalisations is supported by the phenomena of isomorphism (Mitscherlich's law), though of course the result is only strictly true when all the atoms or radicles attached to the central atom are identical, and attract each other with a force *much less* than the repulsive force which exists between the electrons by which they are attached to the surface of the central atom.

The second generalisation has, in a less general form, been already enunciated by Mr. Pope as a result of his experimental researches (*Journ. Chem. Soc.*, 1900, lxxix., 828).

Kiel, March, 1903.

ORIGIN OF THE WORD "BAROMETER."*

By H. CARRINGTON BOLTON.

The instrument familiar to us all as the barometer was first universally known by the name of its inventor as "Torricelli's tube"; de Guericke, the inventor of the air-pump, called his huge water-barometer "Semper Vivum," also "Weather Mannikin," with the Latin form "Anemoscopium.

Soon after the year 1665 the words "baroscope" and "barometer" came into general use in England, but the individual to whom the credit belongs for originating these terms has not been certainly known; the assertion made by a contributor to the *Edinburgh Review* for 1812 that "baroscope" was first used by Prof. George Sinclair, of Scotland, in 1668, is an error, for both words occur in the *Philosophical Transactions* four years earlier. The passage is unsigned, and reads thus:—

"Modern Philosophers, to avoid Circumlocutions call that Instrument, wherein a Cylinder of Quicksilver, of between 28 and 31 inches in Altitude, is kept suspended after the manner of the Torricellian Experiment, a Barometer or Baroscope, first made Publick by that Noble Searcher of Nature, Mr. Boyle, and imployed by him and others to detect all the minut variations in the Pressure and Weight of the Air."

The mention of the words in connection with the name of Robert Boyle has led me to make a close examination of his voluminous and prolix writings. In Boyle's first publication, "New Experiments Physico-Mechanical touching the Spring and Weight of the Air," dated 1660, the words baroscope and barometer do not occur; he uses the common term "tube," and often writes of the "mercurial cylinder." Nor are these words used by him in his "Defense of the Doctrine touching the Spring and the Weight of the Air . . . against the objections of Franciscus Linus," a paper published in 1662.

Their use by the anonymous writer to the *Philosophical Transactions* in 1665 has been shown, and the question arises who was this person who modestly concealed his name; I believe it was Boyle himself. This eminent man, who was so devoid of personal ambition that he declined a peerage, had a habit of writing about himself and his scientific labours in the third person, and often spoke of himself by fanciful fictitious names, such as "Philaretus" (in his fragmentary autobiography) and "Carneades" (in the "Sceptical Chymist"). That he should send an unsigned communication to a journal was not surprising, particularly as he had occasion to mention himself.

Be this as it may, my claim that Boyle originated the word barometer does not rest on such slender conjectures as these. One year later than the communication in the *Philosophical Transactions*, Boyle wrote to this journal (dated April 2, 1666) and says:—"Barometrical observations (as for brevity's sake I call them)," using the personal pronoun this time. Elsewhere in the same paper are found the terms barometer, baroscope, and baroscopical observations.

In his "Continuation of New Experiments Physico-Mechanical . . ." of which the preface is dated 1667, occurs the following phrase:—"But though about the barometer (as others have by their imitation allowed me to call the instrument mentioned)," (Boyle's Works, Birch's Edition, Vol. III., p. 219, London, 1744).

This sentence is virtually an admission by Boyle that he had coined the word, since others imitating him had allowed and encouraged him to use the term to designate the tube of Torricelli.

I conclude, therefore, that the word "barometer" was introduced into our language by the English philosopher, the Hon. Robert Boyle, about the year 1665. Boyle, by the way, was a scholar and able to use Greek in forming an English word. Finally, I may add that examination of Murray's, Skeats', and other standard English dictionaries throws no light on the origin of the word; they merely refer to the *Philosophical Transactions*, and give its obvious etymology.

* Advance proof from *Science*.

ON THE GRAVIMETRIC ESTIMATION OF TELLURIUM.

PART II.

By R. W. EMERSON MacIVOR, F.I.C., &c.,
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In this communication I propose to deal with the merits or otherwise of several gravimetric processes for estimating tellurium which were not discussed in my previous paper (Chemical News, vol. lxxxvii., p. 17), and also to notice some peculiarities of the precipitated so-called element which I think are likely to have special interest for analytical chemists.

Stannous chloride was employed by the earlier chemists, and is still recommended in some of our principal text-books as a precipitant of tellurium from tellurous solutions, and although known to be so efficient that by its aid one part of the element in 70,000 parts of solution can be detected, it is found in quantitative work that the precipitate thrown down by it is never pure, but always contains a variable quantity of tin which cannot, without very considerable trouble and loss of time, be separated or allowed for, and therefore interferes more or less seriously with the accuracy of the final result. On this ground alone I am unable to endorse the favourable opinion expressed by some authorities regarding the $SnCl_2$ method of precipitation.

Donath states (*Zeit. Ang. Chem.*, 1890, p. 214—217) that in his opinion hyposulphurous acid is a good reducing agent for TeO_2 in cold concentrated acid solutions, and that the precipitating liquid may be easily prepared by digesting metallic zinc in an aqueous solution of SO_2. It is asserted that when this liquid is mixed in some excess with the tellurous solution, complete precipitation takes place in about fifteen minutes. On testing the process, I found, however, that a perfect separation of tellurium cannot be brought about in the cold, and, even if this were possible of attainment, the precipitate produced is in nature so finely divided that its collection and after treatment is tedious work. But if the mixed solution is heated to boiling-point for a sufficient length of time—and this will vary according to circumstances—the whole of the tellurium will ultimately come down in a form in which it can be easily manipulated as far as the merely mechanical process of washing and filtering are concerned; on the other hand, the precipitate contains an admixture of sulphur, which is not constant in amount, and which can only be removed by extraction with CS_2, or by prolonged heating in a stream of inert gas at a temperature of 250° or so, whereby the sulphur is vaporised and carried off. Oxidation with HNO_3 in a porcelain crucible and subsequent gradual heating to over 400° has been suggested as a simpler method of dealing with this unsatisfactory precipitate, but I have found that before the last traces of acid can be expelled from the TeO_2 formed, a not inconsiderable quantity of the latter also volatilises. In view of these facts I fail to see that Donath's method can in any sense be considered an advantageous substitute for the ordinary sulphite process.

I now come to speak of the grape or invert sugar reduction process devised by Stolba thirty years ago (*Jahr. f. Chem.*, 1873, 214), and approved by Kastner (*Zeit. Anal. Chem.*, 1875, 142), and in later years by other workers. It has much to recommend it on the score of simplicity, ease of execution, and reliability. It is necessary that the tellurous solution to be precipitated after neutralisation with Na_2CO_3 (in some excess) should be heated to boiling for a few minutes before the sugar solution is mixed with it, and this should be done in considerable excess, so that perfect precipitation may be effected and the oxidation of the tellurium prevented; the mixed solution should be boiled for about twenty minutes, rarely longer. In the condition in which it comes down the precipitate can be washed by decantation (which should be done over and over again with hot water), and afterwards on the filter with, first, water, and afterwards repeatedly with alcohol; it shows less tendency to absorb oxygen—or at least appeared to me to do so—than the tellurium thrown down in acid solution. I find the Stolba process a convenient one in the analysis of telluriferous minerals. The material, in a finely ground state, should be digested for a time—an hour is usually long enough even in the case of an obstinate mineral—in strong HNO_3, the mass then evaporated to almost dryness over the water-bath, and the residue boiled for thirty minutes or so in a strong solution of NaOH. Water is next added, and the hot solution filtered, some HCl is next added to the filtrate in order to destroy its excessive alkalinity, and the liquid evaporated to small volume. To this still alkaline solution an excess of the sugar solution is now added, and the whole boiled for about twenty minutes, when precipitation should be complete. The precipitate should be collected and treated in the manner just explained.

The powerful deoxidising properties of hydrazine hydrate and its hydrochloride have recently been applied by Gutbier (*Ber.*, 1901, [12], 2724—2726) to the quantitative precipitation of tellurium from both telluric and tellurous solutions. To acid solutions either of these compounds may be added, but in the case of an alkaline solution it is advised that the hydrochloride should be used. In his paper the inventor confines the description of his method of working the process to the reduction of telluric acid solutions, and leaves the reader to adapt it as he may think best to other tellurium compounds. To the warm telluric solution, contained in a capacious porcelain (or platinum) dish provided with a spout, and also with a glass (or platinum) cover, a 10—20 per cent solution of either $N_2H_4H_2O$ or the hydrochloride is added by aid of a pipette inserted in the spout, the dish being meanwhile kept well covered to prevent loss by spirting. The reduction at once commences, being indicated by the liquid becoming dark blue or nearly black, and after heating to 100° for a few minutes the solution clears again while the tellurium separates in a flocculent condition. Successive additions of the reducing agent are made until it ceases to cause colouration, and when this point is reached the whole of the tellurium will have separated from the solution. The precipitation is much facilitated by heating the solution after each addition of the precipitant, and the supernatant liquid should be passed through the tared filter upon which the bulk precipitate is ultimately put, after having been thoroughly washed (by decantation) with hot water containing a little $N_2H_4H_2O$ to prevent oxidation. I cannot pretend to have had much experience with the Gutbier process, nor am I now likely to have for some time to come, but so far as my few trials of it can guide me to an opinion, I am disposed to believe it has advantages not possessed by certain other methods—even the sulphite process. The point of complete precipitation is easily struck, since a fresh addition of the reagent will no longer impart a colour to the solution; the precipitate separates quickly and in excellent condition for after treatment, and its oxidation is reduced to a minimum.

Properties of Tellurium Precipitates.

If there is a substance of all others which demands that the solutions from which it is to be precipitated should be as concentrated as possible before the precipitating agent is mixed with them, it is surely tellurium. From dilute solutions it is not only very difficult to obtain the perfect separation of the element, but the form in which it is precipitated renders its collection and general management most wearisome and unsatisfactory. Tellurium should, whenever possible, be thrown down from hot or boiling solutions, and the heating should be continued (always in the presence of an excess of the reducing agent) until the precipitate has so aggregated that it settles well and can be filtered and washed with facility. "It is to be noted," says Crane, who has had a long experience of the subject, "that differences in the concentration (and temperature) of the tellurium solution in which the precipitation takes place may markedly influence the character of the precipitate." Only those who have had much to do with tellurium precipitates can appreciate to the full the truth of these few words.

It has been shown that precipitated tellurium is with difficulty freed from the acids it may bring down with it from solution, particularly H_2SO_4 and HCl. Thus Brauner (*Journ. Chem. Soc.*, vol. lv.) found a precipitate (produced by SO_2 in an acid solution of TeO_2) which had been most carefully washed first with water and then with alcohol, and dried at 110°, still retained appreciable quantities of these two acids, and on being heated to 300° in a current of hydrogen gave off vapours which, when passed into a solution of $AgNO_3$, caused a white precipitate of AgCl, and experienced a loss in weight equivalent to 0·31 per cent. This quantity may not at first sight appear important, but when we take into consideration that at the time Brauner made this experiment he was engaged in a most painstaking original research, which, of course, demanded that all his operations should be conducted with an attention to detail and exactitude of manipulation not bestowable on every-day analytical work, the seemingly small quantity of acid impurity which he found in his precipitate has some significance, inasmuch as it indicates the probability of a precipitate similarly obtained and handled in an ordinary laboratory fashion containing an amount of either, or both, of the

acids named which cannot by any means be considered negligible. To remove this impurity, or at least to bring it within a reasonable limit of error, the precipitate should, after a first weighing, be exposed for some time to a temperature of 250—300° in a current of inert gas, say dry CO_2, and again weighed; or it may be digested for a few minutes in hot water containing a little NH_3, again filtered, washed, and dried at 105°. By the latter means I succeeded in extracting from a precipitate which had previously been well washed by decantation and in the filter, 0·198 and 0·397 per cent of HCl and H_2SO_4 respectively. The final weight of this precipitate, I may mention, was 1·6958 grm.

With regard to the absorption of oxygen by tellurium precipitates while still in the solutions in which they were formed and during the processes of washing and drying, I have already said a good deal (Chemical News, vol. lxxxvii., 17), but it is desirable that I should here further refer to it. The extent to which this process will occur while the tellurium remains in contact with the acid liquid will, of course, much depend on circumstances, but, according to Norris and Fay (*Am. Chem. Journ.*, xx., p. 278), the quantity of precipitate which undergoes oxidation in the case of the ordinary sulphite process and which remains behind in the solution as tetrachloride, is, under ordinary conditions of analysis, about 0·5 per cent, and these authorities look upon this loss as being compensated for by a corresponding increase in weight of the precipitate due to the absorption of oxygen during the operations of washing and drying. Thus it is argued that the result obtained by the sulphite process is "approximately true." I have, however, found that a tellurium precipitate weighing 2·5893 grms. increased in weight to the extent of over 2 per cent during six hours' drying at 105°, and this could only arise from the absorption of oxygen. The same precipitate, after being freed from TeO_2 and dried in CO_2 at 110°, was left in the dry atmosphere of a balance case for four months without undergoing the slightest oxidation. Crane suggests (*Am. Chem. Journ.*, xxiii., p. 419) that though the oxidation of the precipitated element is obviously influenced by circumstances, it need not at all seriously affect the final result; it can not only be very easily detected, but its actual extent can be accurately judged. By removing the precipitate from the filter, after it has been weighed, and putting it in a beaker on a white surface or in a white (porcelain) dish and moistening it with strong HCl, any TeO_2 present dissolves, and imparts to the acid the characteristic yellow tint of $TeCl_4$, leaving the unoxidised element untouched, it being absolutely insoluble. The tint should appear immediately the HCl comes in contact with the substance; if, however, it is not then perceptible and only becomes so after some time, it will be due to the oxidation of the tellurium by the air after the addition of the HCl, and not to TeO_2 in the precipitate before this addition was made. With the object of determining how far this colour of $TeCl_4$ could be utilised "as a criterion of the presence of TeO_2 and its amount," Crane dissolved 0·0068 grm. of $TeCl_4$ in HCl, and, on gradually diluting the solution with water, found that the yellow tint of a layer 0·25 cm. "thick" was clearly distinguishable when only 0·00013 grm. of the tetrachloride was present in each c.c.

To prevent, or at least minimise, the oxidation of tellurium precipitates, it is necessary that they should be rendered quite free from the acids mentioned above, as the presence of these appears to assist the process, and in filtering off they should be kept as well covered with liquid as possible so as to exclude air; it is sometimes well, also, to finally wash with pure alcohol. Whenever possible, the Gooch system of filtration should be adopted.

Condensation of the Nitrated Derivatives of Chloride of Benzyl with the Naphthylamines.—MM. G. Darier and E. Mannassewitch, in a very long paper, describe the preparation of a number of colouring matters; they are all very slightly affected by acids and alkalis.—*Bull. Soc. Chim.*, Series 3, vol. xxvii., Nos. 20—21.

THE LECITHANS: THEIR FUNCTION IN THE LIFE OF THE CELL.*

By WALDEMAR KOCH.

(Concluded from p. 150).

Preparation and Analyses of Various Lecithans.

Egg Lecithin.—The yolks of ten eggs are allowed to stand with 600 c.c. ether over night, 1 litre alcohol added, the solution filtered and evaporated on water-bath. The residue is dissolved in 200 c.c. cold ether, and 1 litre acetone added. The precipitated lecithin is treated over night with 1 litre cold alcohol, the solution filtered and evaporated. The residue is once more dissolved in ether, precipitated with acetone, and dried over sulphuric acid in a vacuum desiccator.

I.† 0·8113 g. of the substance gave 0·1136 g. $Mg_2P_2O_7$, *i.e.*, 3·91 per cent P.

II. 0·9150 g. of the substance gave 0·1278 g. $Mg_2P_2O_7$, *i.e.*, 3·90 per cent P.

III. 0·330 g. of the substance gave 0·3001 g. AgI, *i.e.*, 5·80 per cent CH_3.

IV. 0·325 g. of the substance gave 0·2960 g. AgI, *i.e.*, 5·81 per cent CH_3.

V. 0·320 g. of the substance gave, below 240° C., 0·0760 g. AgI, *i.e.*, 153 per cent CH_3. The methyl iodide given off above that temperature was lost on account of an accident. In III. and IV. the methyl iodide came over at 220° C. and 300° C. The two portions were not separated.

		Found.		
		III.	IV.	V.
Phosphorus as 3·97 calculated for $3CH_3$	5·66	5·80	5·81	—
Phosphorus as 3·97 calculated for $1CH_3$	1·88	—	—	1·53

Brain Lecithin and Kephalin.—One kilo. sheep's brains is minced in a meat-chopper, and freed from water and extractives by boiling with 1 kilo. acetone for eight hours. The solution is filtered cold, and the remaining acetone removed from the brains by gentle heating at 50° C. Seven hundred c.c. cold ether are now added and allowed to stand for three days, the solution is filtered, and another portion of ether added, and again allowed to stand. The ether filtrates are united and slowly evaporated to one-fourth their original volume in a tall beaker. The solution is then carefully removed by means of a pipette from the white precipitate, which has settled to the bottom, and 1·5 kilo. alcohol is added to the solution.

Kephalin.—The precipitated kephalin is extracted five times with boiling alcohol, dissolved in ether, precipitated with acetone, again dissolved in ether, and allowed to settle in a long, narrow, closed test-tube. The clear ether solution is removed by decantation, evaporated, and the residue re-crystallised twice from hot acetic ether. The resulting kephalin is very hygroscopic, and must be dried over sulphuric acid for analysis. It agrees perfectly in all its properties with the kephalin described by Thudichum (p. 127). On analysis it gave the following results:—

I. 0·2469 g. of the substance gave 0·5388 g. CO_2 and 0·2159 g. H_2O, *i.e.*, 59·5 per cent C. and 9·7 per cent H.

II. 0·415 g. of the substance neutralised 5·2 c.c. *n*/10 acid, *i.e.*, 1·78 per cent N.

III. 0·9644 g. of the substance gave 0·1330 g. $Mg_2P_2O_7$, *i.e.*, 3·85 per cent P.

IV. 0·7235 g. of the substance gave 0·0990 g. $Mg_2P_2O_7$, *i.e.*, 3·82 per cent P.

V. 0·3488 g. of the substance gave, below 240° C., 0·0945 g. AgI, *i.e.*, 1·73 per cent CH_3.

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* From the *Decennial Publications of the University of Chicago*, 1902, vol. x.

† For phosphorus determinations the very excellent method of Neumann was used (Engelmann's "Archiv. für Physiologie," 1900, p. 159).

VI. 0·490 g. of the substance gave, below 240° C., 0·1312 g. AgI, *i.e.*, 17·1 per cent CH_3.

VII. 0·225 g. of the substance gave, below 300° C., 0·0636 g. AgI, *i.e.*, 1·80 per cent CH_3.

VIII. 0·748 g. of the substance was burned with a mixture of nitric and sulphuric acid, the solution diluted, neutralised with 50 g. barium hydrate to remove sulphates and phosphates, the barium removed with sulphuric acid, and the solution evaporated. The ignited residue weighed 0·030 g. Some of this must have come as an impurity from the barium hydrate. In any case, the amount is not sufficient to account for any more than an impurity. Thudichum (*op. cit.*, p. 130) has also found his kephalin to contain small amounts of inorganic substances as impurities. My analyses agree fairly well with Thudichum's (p. 132).

Thudichum:—C, 60·0; H, 9·38; N, 1·68; P, 4·27.
My results:—C, 59·5; H, 9·7; N, 1·78; P, 3·84.

The methyl groups correspond very closely to one methyl for one nitrogen. That this is not due to the presence of lecithin as an impurity is shown by the fact that the methyl is all split off below 240° C.

		Found.			
		II.	V.	VI.	VII.
Phosphorus as 3·83 calculated for $1CH_3$ ..	1·85	—	1·73	1·71	1·81
Phosphorus as 3·83 calculated for 1N.. ..	1·78	1·78	—	—	—

Lecithin.—The original alcohol-ether filtrate from which the kephalin has been removed by filtration is evaporated to dryness, and the residue dissolved in ether and freed from cholesterin by precipitation with acetone. The precipitated lecithin is treated with a large quantity of cold alcohol for some time, and the solution filtered and evaporated. The resulting lecithin should dissolve readily and completely in cold alcohol or ether. If this is not the case, the extraction with cold alcohol must be repeated. Finally, the lecithin is dissolved in hot acetic ether, and allowed to separate out by cooling, dried over sulphuric acid, and analysed.

I. 0·2420 g. of the substance gave 0·5683 g. CO_2 and 0·2420 g. H_2O, *i.e.*, 64·04 per cent C; 10·4 H.

II. 0·942 g. of the substance neutralised 12·1 c.c. *n*/10 acid, *i.e.*, 1·8 per cent N.

III. 0·677 g. of the substance gave 0·0919 g. $Mg_2P_2O_7$, *i.e.*, 3·79 per cent P.

IV. 0·815 g. of the substance gave 0·1109 g. $Mg_2P_2O_7$, *i.e.*, 3·80 per cent P.

V. 0·3975 g. of the substance gave 0·3156 g. AgI, *i.e.*, 5·1 per cent CH_3.

VI. 0·235 g. of the substance gave 0·1853 g. AgI, *i.e.*, 5·03 per cent CH_3.

My lecithin agrees fairly well in its properties with the one isolated by Thudichum (p. 116). The results of the methyl-group determination show as good an agreement with the theory as can be expected from a compound so difficult to purify.

		Found.		
		III.	V.	VI.
Phosphorus as 3·8 calculated for $3CH_3$	5·51	—	5·1	5·03
Phosphorus as 3·8 calculated for 1N	1·72	1·8	—	—

Lecithans from Yeast.—Twenty yeast cakes are mixed well with 1 litre of alcohol in a flask and boiled for eight hours, filtered, the yeast allowed to stand with ether over night, filtered, the filtrates united, and evaporated. The residue is extracted with cold ether, three times the volume of acetone added, and the resulting precipitate dried *in vacuo* over sulphuric acid, as it is not sufficient for further purification. The substance thus obtained resembles kephalin in that it darkens rapidly on exposure to the air, and is precipitated from ether solution by alcohol. The analysis gave the following result:—

I. 0·220 g. of the substance gave 0·0286 g. $Mg_2P_2O_7$, *i.e.*, 3·63 per cent P.

II. 0·165 g. of the substance gave 0·0626 g. AgI, *i.e.*, 2·42 per cent CH_3.

The methyl iodide was split up mostly at 240° C., but some more was obtained on raising the temperature to 300° C.

		Found. II.
Phosphorus as 3·63 calculated for $1CH_3$	1·76	2·42
Phosphorus as 3·63 calculated for $2CH_3$	3·51	—

The amount of methyl is not sufficient to account for two groups, and as the compound was not especially freed from lecithin, it seems reasonable to account for the extra methyl as due to an impurity of lecithin which would amount to about 11 per cent. The main bulk of the body is, therefore, kephalin, which agrees well with the other observations.

The results so far obtained with the Herzig and Meyer methyl group determine, then, that the two principal classes of lecithans differ, not only in the fatty acid group, but also in the complex which contains the nitrogen. Very striking is the fact that kephalin occurs only in living cells, such as the nerve or yeast cell, and is not found in the egg, which consist mostly of stored food material. Kephalin may possibly be an intermediary product in the decomposition of lecithin. The low amount of carbon and the correspondingly large amount of oxygen would indicate an addition of oxygen in the oleic-acid radical of the lecithin—a hypothesis which leaves unexplained the fact that kephalin is, if anything, more unsaturated than lecithin, judging by the relative amounts of iodine absorbed. At any rate, there is at present not enough known about the nature of kephalinic acid to trace its origin to oleic acid. As far as the nitrogen complex is concerned, it is possible that two methyl groups have been split off, leaving a mono-methyl oxæthylamin. Thudichum (*op. cit.*, p. 147) has, indeed, isolated from his kephalin a base which contains less methyl groups, but he has also mentioned the presence of neurin. My results, however, show conclusively that neurin can be present only as an impurity. The decomposition of 20 grms. of kephalin with barium hydrate yielded only 0·2 g. of a platinum salt, which corresponded, on analysis, to something between a mono- or a di-methyl oxæthylamin. The investigation of this interesting relation will be continued, and the methyl-group determination described above will undoubtedly be of value in following out the quantitative relation of lecithin to kephalin under various conditions in the living cell. The other lecithans, such as the myelins, paramyelins, and amidomyelins, isolated by Thudichum from brain tissues, do not seem to occur in any large quantity, and have not as yet been investigated.

Physiological Properties.

Substances of such importance to the cell as the lecithans must possess some value as foods. The action of the digestive ferments is therefore of especial importance, as neurin, which is formed by the decomposition, has been shown by Halliburton (*op. cit.*, p. 55) to have a decided effect on blood pressure. A. Bókay (Hoppe Seyler's *Zeit. für Phys. Chem.*, 1877, vol. i., p. 157), under the direction of Hoppe Seyler, investigated this problem and found that lipase will split egg lecithin into glycerophosphoric acid, fatty acids, and neurin. The three splitting products must, however, be immediately absorbed and re-synthesised, as they are not found in the urine or fæces, and a meal containing considerable lecithin has never been known to cause any bad effects. The results on the metabolism of the injection of lecithin into the circulation are as yet in too unsatisfactory a state to be discussed. The patenting (C. Zerbe, *Chemiker-*

Zeitung, 1902, vol. xxvi., p. 17; Deutsches Reichs-Patent, 127357) of brain preparations for medical purposes seems, therefore, especially premature.

For completeness sake a number of facts have been mentioned in this paper which have been known for a long time. The new facts are as follows:—

1. The word "lecithan" is to be used as a group name, including such compounds as egg lecithin, brain lecithin, kephalin, myelin, paramyelin, &c.

2. The emulsion formed by the lecithans may be the substratum in which the reactions of the cell take place. The precipitation of this emulsion by divalent kations is prevented by univalent and trivalent kations, as far as investigated, and this observation may furnish an explanation of the changes brought about by electrolytes in the living cell.

3. Kephalin is found only in the living cell, and may be an intermediary product in the metabolism of lecithin.

4. An accurate method for determining lecithin and kephalin quantitatively.

NOTICES OF BOOKS.

Analytical Chemistry. By F. P. Treadwell. Translated (with the Author's permission) from the Second German Edition by William T. Hall. Volume I. "Qualitative Analysis." New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1903. Pp. xi.—466. 8vo.

This book reproduces in a somewhat amplified form the author's lecture to students at the Polytechnic Institute of Zürich. It is designed for laboratory use as well as for "self study," as the translation of the preface puts it, and it contains much information usually found in text-books of general chemistry and of mineralogy. With each element, besides the analytical reactions, the mineralogical occurrence, crystalline form, and isomorphous relations are briefly mentioned; these include many details of descriptive mineralogy. The reactions of the metals forming distinct groups are followed by methods of separation given in schematic tables. Under reactions of the metalloids (anions) those of the acids are given. Part II. is devoted to the systematic course of analysis, and in a Supplement are reactions of some of the rarer metals, arranged in their natural groups.

The introduction has chapters on the Law of Chemical Mass Action, the Ion Theory of Arrhenius, Hydrolysis and Determination of the Sensitiveness of Reagents, a subject on which the author lays much weight (see preface). The section dealing with the reactions of sodium peroxide is followed by one on the reactions of hydrogen peroxide. The method of spectrum analysis is briefly explained in five pages.

A feature of this book is the unusual number of equations explanatory of reactions that are scattered throughout its pages. The author's fondness for representing these reactions by structural formulæ caused them to occupy much space, as seen on pages 100, 117, and 149.

Novelties are rather seldom introduced, but tried methods are given places in the volume, such as Gutzeit's test for arsenic, Griess's test for nitrous acid, and Hillebrand's method for detecting vanadium in rocks. Some of the typographical errors are peculiar; "Bunsen and Kirschhoff" occurs twice, though there is little in churchyards to suggest cherries. The translator has made an attempt to correct the mis-spelling of Kirchhoff in the Supplement, but in vain; it is there given as "Kirchoff"! "Sodium santhogenate" (p. 174) looks unfamiliar, and "tantallium" in the table of contents is supposed to refer to tantalum, which is correctly spelt in the text. This table, by the way, does not correspond accurately with the sections in the volume, especially between pages 19 and 35.

Historical details are rather unequally inserted; the names associated with the discovery of uranium are mentioned, but under neo-dymium and praseo-dymium, no chemist receives credit for his labours on these elements, and under thallium there is no reference to Crookes. The index at the end of the volume is inadequate and rather carelessly made, but these blemishes do not materially detract from the value of the work for the purpose for which it was written. H.C.B.

Chemical Technology, or Chemistry in its Applications to Arts and Manufactures. With which is Incorporated Richardson and Watts' "Chemical Technology." Vol. IV. Edited by W. J. Dibdin, F.I.C., F.C.S., &c. London: J. and A. Churchill. 1903. Pp. 378.

This volume is divided into two distinct portions; the first two hundred and seventy-seven pages are on "Electric Lighting," written by Mr. A. G. Cooke, M.A., &c., and the remainder of the book, comprising one hundred pages, is on "Photometry," and is written by Mr. W. J. Dibdin, who is also the editor of the whole.

We may describe this work as an eminently practical one, though theoretical considerations are by no means neglected, but have indeed several important sections devoted to their study.

The author begins with a short general survey of the functions of what we may call "heavy" electric currents, and then proceeds to the subject of conductors and their accessories.

The different forms of dynamo are dealt with next, both theoretically and practically; this is followed by sections on storage batteries, transformers, and series distribution. We then come to the theory and practice of alternating currents, sections on incandescent and arc lamps; and finally there is a section on "Central Station Economy," which deals with such important items as fuel, boilers, efficiency of machinery and distribution, meters, and methods of charging for electrical energy.

Photometry is a subject very closely allied with the production and distribution of electric light. The laws governing photometry are at first sight extremely simple, the principal one being the law of inverse squares. In practice, however, the subject is surrounded with a number of small difficulties, the chief one being the production of a trustworthy standard of light. The candle has the merit of simplicity and portability, but it is not to be relied upon to the same extent as the more modern lamps, such as Harcourt's pentane flame, and similar substitutes, a number of which are fully described in pages 336 to 353. There are also a number of photometers described; they are naturally all based on the same principle, and are known by the various names of their designers. The book is well written and planned, and will undoubtedly be of service to electrical engineers and others connected with, or interested in, the subjects dealt with.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 10, March 9, 1903.

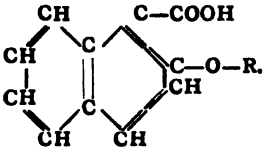
Preparation and Properties of Rubidium and Cæsium Hydrides.—Henri Moissan.—The author finds that rubidium and cæsium unite directly with hydrogen, giving crystalline compounds having formulæ RbH and CsH. These substances are very energetic reducing agents, decomposing water, hydrogen sulphide, and hydrochloric acid at ordinary temperatures. With sulphurous acid at a low temperature they give hydro-

sulphites,; with carbonic acid, and by direct union of the formates with ammonia, amides are formed. These researches complete the author's proof that all the alkaline metals give with hydrogen definite binary compounds, which are crystalline and have the formula RH.

Electric Non-conductivity of Metallic Hydrides.—Henri Moissan.—The author examines the electric conductivity of metallic hydrides, and finds that hydrogen is not comparable in this property with the metals; also that the metallic hydrides are not in any way akin to alloys in chemical or electrical properties. The liquefaction of hydrogen by Professor Dewar confirms the fact that it is more allied to oxygen or nitrogen than to mercury, cæsium, or gallium. Also liquid hydrogen, in the same way as the metallic hydrides, is a non-conductor of electricity.

Cuprous Sulphate.—A. Joannis.—In a previous paper the author described a compound of carbonic oxide and cuprous sulphate in solution which has the curious property of dissociating and giving cupric sulphate and particles of metallic copper on the surface of the solution. This substance, which apparently has the formula $SO_4Cu_2,2CO,H_2O$, decomposes in a vacuum, whether solid or dissolved, and the present experiments seem to show that cuprous sulphate cannot exist in the free state.

Certain Derivatives of Oxy-2-naphthoic-1 Acid.—F. Bodroux.—When bromo-1-naphthol-2 acts on alcoholic iodides in presence of potash, the acid produced evidently has the constitution—



MISCELLANEOUS.

Royal Institution.—The following are the Lecture Arrangements at the Royal Institution, after Easter:—Prof. Allan Macfadyen, three lectures on "The Blood and some of its Problems"; Prof. G. H. Darwin, two lectures on "The Astronomical Influence of the Tides" (The Tyndall Lectures); Prof. E. J. Garwood, two lectures on "The Work of Ice as a Geological Agent"; Prof. Dewar, three lectures on "Hydrogen: Gaseous, Liquid, and Solid"; Prof. S. H. Vines, two lectures on "Proteid-Digestion in Plants"; Prof. J. A. Fleming, two lectures on "Electric Resonance and Wireless Telegraphy"; Prof. Langton Douglas, two lectures on "The Early Art of Siena"; Hamish MacCunn, Esq., two lectures on "Music" (with Musical Illustrations); and Prof. Silvanus P. Thompson, two lectures on "The De Magnete and its Author, (1) The Book, (2) The Man." The Friday Evening Meetings will be resumed on April 24th, when a Discourse will be given by the Hon. R. J. Strutt on "Some Recent Investigations on Electrical Conddduction"; succeeding Discourses will probably be given by Prof. William J. Pope, Mr. Rider Haggard, Dr. D. H. Scott, Dr. J. A. H. Murray, His Serene Highness Albert Prince of Monaco, and other gentlemen.

Science in the Provinces.—The recent development of scientific teaching in Ireland has led to the formation in Cork of a new society for the cultivation of science and the promotion of its application to industry. The society has been named the Cork Scientific Association, and its Officers are:—President, Wm. B. Harrington, F.C.S.; Vice-Presidents, Rev. Br. D. J. Burke, Prof. Corby, M.D., G. Fletcher, Dept. Ag. and Tech. Ind., Prof. Marcus M. Hartog, M.A., D.Sc.; Hon. Secs., H. G. W. Adan, B.Sc., T. Farrington, M.A., F.I.C., F.C.S., and A. Coulthard, B.Sc.; Hon. Treas., Jas. Comerton, B.A. Three of the monthly meetings have already been held, at which the following papers have been read and discussed:—"On Science Teaching in Irish Schools," by Rev. Br. Crehan; "On a Proposed New Method for Ascertaining the Genuineness of Milk," by T. Farrington, M.A., F.I.C., F.C.S.; "On the Nature of Flame and the Cause of Luminosity," by A. Coulthard, B.Sc. At the next meeting, to be held on Monday, April 20th, Prof. Marcus M. Hartog, M.A., D.Sc., will read a paper on "Ferments," and the Session will close in the following month with a lecture by Mr. G. Fletcher on "Glacier Motion." The Society's activity does not, however, terminate with the close of its Session, as arrangements have been made by which its members are kept in touch with the advance of Science through the circulation of the leading scientific journals all the year round.

MEETINGS FOR THE WEEK.

MONDAY, 6th.—Royal Institution, 5. General Monthly Meeting.
Society of Chemical Industry, 8. "The Manufacture of Iodine from Nitrate Liquors," by Dr. W. Newton, F.I.C., &c. "New Modification of Coffignier's Prussian Blue Reaction, and a Possible Application," by Watson Smith, F.I.C., &c. "The Explosion of Potassium Chlorate at St. Helens," by Dr. A. Dupré, F.R.S.

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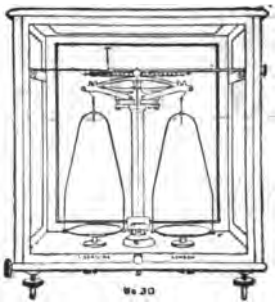

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THE CHEMICAL NEWS.

Vol. LXXXVII., No. 2263.

A RE-DETERMINATION OF THE ATOMIC WEIGHT OF LANTHANUM.*

By HARRY C. JONES.

A number of determinations of the atomic weight of lanthanum have already been made. The more important and reliable are the following:—

Rammelsberg (*Pogg. Ann.*, 1842, lv., 66) precipitated the sulphuric acid in lanthanum sulphate as barium sulphate. He found the atomic weight of lanthanum, from one determination, to be 133·4.

In the same year Choubine (*Journ. Prakt. Chem.*, 1842, xxvi., 443) published determinations of the atomic weight of lanthanum. He transformed the oxide into lanthanous chloride, and then precipitated the chlorine by means of silver nitrate. The two determinations gave values lower than that found by Rammelsberg, but Choubine's material was almost certainly contaminated with other substances.

The same criticism applies to the work of Hermann (*Journ. Prakt. Chem.*, 1843, xxx., 199), who, the following year, made a few determinations of the atomic weight of lanthanum.

The first determination of the atomic weight of lanthanum upon which much stress can be laid is that of Marignac (*Arch. Sci. Phys. et Nat.*, 1849, [1], xi., 29). He titrated solutions of lanthanum sulphate with a solution of barium chloride. As a mean of nine determinations he found the atomic weight of lanthanum to be 140·2.

Holzmann (*Journ. Prakt. Chem.*, 1858, lxxv., 343) attempted to determine the atomic weight of lanthanum by several methods. He analysed the sulphate by precipitating the lanthanum as oxalate, igniting the oxalate, and weighing the oxide. From three determinations he obtained for the atomic weight of lanthanum the value 138·8. He also analysed the iodate of lanthanum by precipitating the lanthanum as oxalate and determining the iodic acid volumetrically. The lower values found by this method cannot be regarded as important, since the method has been shown to be defective. Holzmann also determined the atomic weight of lanthanum by analysing the double nitrate of lanthanum and magnesium, $2La_2(NO_3)_6.3Mg(NO_3)_2.24H_2O$. This method, like that involving the use of the iodate, is open to serious objection.

In 1860 Czudnowicz (*Journ. Prakt. Chem.*, 1860, lxxx., 33) published one analysis of lanthanum sulphate, and a year later Hermann (*Journ. Prakt. Chem.*, 1861, lxxxii., 395) analysed both the sulphate and carbonate of lanthanum. Since the material was not purified with sufficient care, no stress can be laid upon the results obtained.

In 1868 Zschiesche (*Journ. Prakt. Chem.*, civ., 176) freed his lanthanum from didymium, and made six analyses of lanthanum sulphate. The values found for the atomic weight of lanthanum differ more than three units. The mean value is 135·9.

Erk (*Zeit. Chem.*, N.F., vii., 106; *Zeit. Anal. Chem.*, 1871, x., 509) analysed the sulphate of lanthanum by precipitating the lanthanum with ammonium oxalate, igniting the oxalate, and weighing the oxide. The mean of three determinations gave for the atomic weight of lanthanum the value 135·5.

Erk also determined the sulphuric acid in the filtrates, and from these results calculated the atomic weight of lanthanum to be 135·3.

Marignac (*Ann. Chim. Phys.*, 1873, [4], xxx., 68) redetermined the atomic weight of lanthanum by further purifying the sulphate by repeated crystallisation. In two determinations the sulphate was heated to dull redness, weighed, and then heated to a white heat to convert the sulphate into oxide. In two other determinations the dried sulphate was dissolved, and the solution treated with a solution of ammonium oxalate. The oxalate of lanthanum was strongly heated to convert it into the oxide, and the oxide weighed. By the first method Marignac obtained for the atomic weight of lanthanum the value 138·9; by the second method the value 138·7.

Clève (*K. Svensk. Akad. Handlingar*, 1874, ii., 7) made five determinations of the atomic weight of lanthanum in 1874. The oxide, analysed spectroscopically, was dissolved in nitric acid. The solution was treated with sulphuric acid, evaporated to dryness, and the residue heated to remove all excess of sulphuric acid. The amount of sulphate formed was then weighed. The mean of Clève's determinations gave, for the atomic weight of lanthanum, the value 139·3.

Brauner (*Monatsh. Chem.*, 1883, iii., 28) made his first determinations of the atomic weight of lanthanum in 1882. In two syntheses of the sulphate from the oxide he obtained for the atomic weight of lanthanum the values 138·94 and 138·83, the mean being 138·88.

In a second series of determinations published in the same year, Brauner (*Monatsh. Chem.*, iii., 493) obtained considerably lower values. With this material, which Brauner thinks was purer than that originally used, he obtained values for the atomic weight of lanthanum ranging from 138·06 to 138·45, with a mean of 138·28.

Clève (*Bull. Soc. Chim.*, 1883, xxxix., 151) published his second series of determinations of the atomic weight of lanthanum in 1883. The material which Clève used was unquestionably purer than any which had been employed up to that time. He made a series of twelve determinations by converting the oxide into the sulphate. The atomic weight of lanthanum calculated by Clève on the basis of $SO_3=80$ varied from 138·07 to 138·35, with a mean of 138·22. Calculated on the basis of the present values for oxygen and sulphur, this becomes 138·55. Of all the determinations of the atomic weight of lanthanum thus far made, this is apparently entitled to the greatest confidence.

Bauer (Dissertation, Freiburg, 1884), in 1890, made four determinations of the atomic weight of lanthanum by converting the oxide into the sulphate. The results calculated in terms of oxygen = 16 and sulphur = 32·06 range from 138·91 to 138·3.

Bettendorff (*Liebig's Ann. Chem.*, 1890, cclvi., 168) made four determinations of the atomic weight of lanthanum by the same method, *i.e.*, the synthesis of the sulphate from the oxide. He calculated the atomic weight of lanthanum on the basis of O=15·96, S=31·98, and obtained values ranging from 138 21 to 138·24. His results calculated on the present basis, of oxygen = 16 and sulphur = 32·06, give as the atomic weight of lanthanum the value 138 62.

Wolcott Gibbs (*Proc. Am. Acad.*, 1893, xxviii., 260) carried out, in 1893, an extensive investigation on the rare earths, with special reference to methods of separating and determining these substances. He analysed the colourless nitrate of ammonium and lanthanum furnished him by Dr. Shapleigh, by precipitating the lanthanum as oxalate and igniting the oxalate. He found for the atomic mass of lanthanum the value 139·7.

Gibbs does not seem to lay much stress upon this result as a determination of the atomic weight of lanthanum, since his work was carried out rather to test certain analytical methods than to purify the several elements and determine their atomic weights. Gibbs states (*Proc. Am. Acad.*, 1893, xxviii., 262) that Shapleigh found values of the same order of magnitude as his own by means of the sulphate method.

The most recent determinations of the atomic weight of lanthanum is that of Brauner and Pavlicek (*Proc. Chem. Soc.*, xvii., 63; also Chemical News, 1903, vol. lxxxvii.,

* From the *American Chemical Journal*, xxviii., No. 1.

p. 49, *et. seq.*). The material was purified by crystallising the double nitrate of ammonium and lanthanum. It was then fused with potassium sodium nitrate and fractionally precipitated with potassium hydroxide. Brauner determined the atomic weight of the lanthanum in the several fractions, and found it to vary from 138·78 in the most positive fraction to 139·1 in the most negative. They regard the most positive fraction as representing the purest lanthanum. They, however, think that since the sulphate is hygroscopic, from 0·2 to 0·3 should be added to the value found by experiment. When this is added to 138·78 they obtained 139·0, which they regard as the true atomic weight of lanthanum.

Brauner and Pavlicek conclude that the sulphate method of determining atomic weights, as ordinarily applied, is unreliable, since the sulphate always contains acid sulphate. They used the sulphate method, but determined the amount of acid sulphate present by titrating with sodium hydroxide, and introducing the corresponding correction.

This conclusion, we shall show, is not based upon a sufficient study of the facts. The presence or absence of acid sulphate depends upon the temperature to which the sulphate has been heated.

It is obvious, from the above sketch of what has been done, that the question of the atomic weight of lanthanum is far from settled. Take even the more recent and trustworthy determinations, and we find a lack of concordance amounting to several units. A careful study of these investigations will show that this is probably due to the different degrees of purity of the materials employed.

Material Used.

The present investigation would not have been undertaken but for the fact that an unusually pure specimen of lanthanum was placed at the writer's disposal by Dr. Waldron Shapleigh, just before his death.

I should like to take this opportunity to express my many obligations to Dr. Shapleigh, in connection with the work already done on the atomic weights of the so-called "rare earths." He isolated lanthanum, praseodymium, neodymium, thorium, and cerium on a scale never dreamed of before his time, and placed the fruit of a score of years at the disposal of those who desired to carry out purely scientific investigations, with a liberality which is rare. Scientific, as well as technical, chemistry, has suffered an irreparable loss by the death of this most genial man.

In addition to having at my disposal remarkably pure ammonium lanthanum nitrate by the kilogramme, the unusual spectroscopic facilities offered by the physical department of this University, in the Rowland spectroscope, made it highly desirable that the atomic weight of lanthanum should be carefully studied.

The double nitrate of ammonium and lanthanum was subjected to fractional crystallisation until spectrum analysis showed that it was homogeneous, and contained as impurity only a trace of cerium. The double nitrate was heated in small quantities over the blast-lamp until only the oxide of lanthanum remained.

To remove any trace of the nitrate which might not have been decomposed, the resulting oxide was boiled for a considerable time with water which had been purified by the method described by Jones and Mackay (*Am. Chem. Journ.*, 1897, xix., 91) for preparing water for conductivity measurements. Indeed, all the water used in this work was purified by this method.

The oxide was filtered off and thoroughly washed with hot water. It was then treated with hot, dilute nitric acid, and dissolved, leaving, however, a slight cloudiness, which was basic cerium nitrate. The solution was then filtered repeatedly through the same filter until it was perfectly clear.

The solution of the nitrate was then treated with a dilute solution of oxalic acid, which had been purified as follows:—Commercial oxalic acid was dissolved in redistilled, cold water. The solution was concentrated by evaporation, and crystals of the acid obtained. The crystals were then dissolved in a mixture of equal parts of pure anhydrous ethyl alcohol and pure anhydrous ether. In this way the oxalic acid was freed from every trace of metallic salts.

To the solution of the oxalic acid in alcohol and ether 3 to 4 volumes of water were added, and the mixture boiled for some time, until the ethyl oxalate formed had been decomposed. The solution was then evaporated, and the oxalic acid allowed to crystallise.

The oxalate of lanthanum was precipitated from the nitrate in the presence of nitric acid. In this way it was separated from all of the more common impurities, such as calcium, iron, &c.

The oxalate was then decomposed to the oxide and analysed spectroscopically by Mr. L. E. Jewell, whose work in this field is so well known. The only impurity which could be detected was a trace of cerium, and this was not more, and probably much less, than 0·01 per cent.

The oxalate was again decomposed to the oxide, the oxide dissolved in hot dilute nitric acid, and the lanthanum precipitated again as the oxalate. The oxalate was decomposed over the blast-lamp, and the resulting oxide used for the following determination:—

To determine whether the oxide prepared in this way contained any oxide richer in oxygen than the sesquioxide, a specimen was heated in an atmosphere of hydrogen. The oxide was placed in a porcelain boat, and the whole weighed. The boat was shoved into a hard-glass tube, and the tube heated in a combustion-furnace until the glass began to soften; a stream of hydrogen, purified by passing through solutions of sodium plumbate and silver nitrate, and dried, being led through the tube. After the oxide had been heated to redness for about an hour it was allowed to cool in an atmosphere of hydrogen, and then placed in a desiccator over phosphorus pentoxide until weighed. No loss in weight could be detected. The oxide was then returned to the glass tube and re-heated for a second hour in an atmosphere of hydrogen. It maintained perfectly constant weight. From these experiments the conclusion was drawn that the oxide of lanthanum prepared by decomposing the oxalate is the pure sesquioxide, free from any higher oxide.

Carrying out a Determination.

The glaze was removed from the inside of a porcelain crucible by treating it with hydrofluoric acid, and the resulting dust brushed out with the greatest care. Indeed, the crucible was scoured with a button-brush turned in a lathe, until every particle of loose material had been removed. This was done to prevent the oxide of lanthanum from coming in contact, while hot, with the glaze on the crucible and the possible formation of a silicate of lanthanum. The glaze was not removed from the exterior of the crucible, since its presence prevented any reducing gases from the flame from passing through the porcelain and coming in contact with the oxide.

The desired amount of lanthanum oxide was placed in the porcelain crucible, and heated over the blast-lamp to constant weight.

A platinum crucible was placed in a weighing tube with a ground-glass stopper, and weighed. The oxide of lanthanum was quickly transferred from the porcelain crucible, in a desiccator containing phosphorus pentoxide, to the plantinum crucible. The latter was quickly introduced into the weighing tube, and the whole re weighed. In this way the weight of the oxide used in an experiment was determined.

The weighings were made to 0·00005 grm. The writer is of the opinion that this is sufficiently accurate for refined atomic weight determinations, since every chemist

s fully aware that the most accurate operation carried out in a chemical laboratory is the weighing with a satisfactory balance. The weighings were made to 0·05 m.grm., and the 0·1 m.grm. nearest to the value found was taken as the true weight. The error in weighing was thus quite as small as in the remaining operations connected with the carrying out of the method.

The oxide was then treated with a measured volume of fairly concentrated sulphuric acid, and warmed very gently until it had been transformed into the sulphate. Unless this precaution is taken the reaction is liable to take place with some violence and cause the substance to spatter upon the sides and top of the crucible. The sulphate was then evaporated slowly to dryness in an upright air-bath, the crucible resting upon a porcelain triangle about 2 c.m. from the bottom of the bath. The sulphate was then heated sufficiently high to decompose all acid sulphates which might have been formed. It was then re-heated until constant weight was established.

Proof of the Absence of Acid Sulphates.

The question of the presence of acid sulphates of lanthanum was studied with care, especially since Brauner (*Proc. Chem. Soc.*, xvii., 63; *Centrbl.*, 1901, 1035) had stated that under these conditions Wyrouboff's acid sulphate was always present. Indeed, Brauner and Pavlicek determined the amount of the acid sulphate present under the conditions with which they worked by titration with sodium hydroxide.

The sulphate of lanthanum which had been heated to constant weight was at first treated with a few drops of a solution of ammonium carbonate, and re-heated. It lost in weight very considerably, and continued to do so as more and more ammonium carbonate was added. This led to the conclusion that the lanthanum sulphate was undergoing decomposition in the presence of ammonium carbonate, giving rise to lanthanum carbonate and ammonium sulphate which was volatilised at the temperature employed. This was proved by the fact that when the lanthanum sulphate was dissolved in water a very considerable insoluble residue remained behind. Indeed, this is just what we would expect when we consider that lanthanum is such a weak base. This is the probable explanation of the fact pointed out by Brauner and Pavlicek that when ammonium carbonate was added to lanthanum sulphate, which had been heated to 450°, a further loss in sulphuric acid took place.

The method of testing for the presence of acid sulphate was the following:—The sulphate was heated to constant weight, and dissolved in water. The solution was perfectly clear, showing that none of the sulphate had been decomposed. The solution was then tested to see whether it would show an acid or basic reaction. In every determination the solution of the sulphate was found to be perfectly neutral, showing not the slightest trace of acid or basic properties.

These facts, together with the complete solubility of the sulphate, show that we had to deal with the normal sulphate, free from both acid and basic salt.

A volume of the sulphuric acid just equal to that used in each determination was evaporated to dryness, and the residue weighed. The residue was found to weigh 0·00002 grm.

(To be continued).

Royal Institution.—A General Monthly Meeting of the Members of the Royal Institution was held on the 6th inst., His Grace the Duke of Northumberland, President, in the Chair. The following were elected members:—Miss M. G. Anderson, Mr. Harold Brown, Mr. T. W. Chitty, Mr. H. T. Crosby, Mr. R A. Hatfield, Mr. W. W. Pope, Miss S. F. de Rodes, and Mrs. G. Orr Wilson.

VOLUMETRIC ESTIMATION OF "TRUE" CASEIN AND OF OTHER ALBUMENOIDS IN MILK.

By M. DENIGÈS.

The method which consists of estimating the total nitrogen in a milk to arrive at its nutritive value, is not founded on a sound principle. In fact, we may agree with Danilewski that only the albumenoid substances, properly so-called, have any nutritive value, while certain peptonic substances, still retaining the property possessed by albumenoids of precipitating Tanret's reagent, have no alimentary value at all. Now, in milk we meet with proteïc matters, much more degraded than the peptones, of which the molecule is sufficiently different from the true albumenoids as not to precipitate the above-mentioned reagent. These substances cannot be regarded as improving the alimentary value, still they are included in the total nitrogen. Thus, it is much more rational to effect the estimation of the nitrogenous principles precipitable by Tanret's reagent or an iodo-mercuric solution in acetic acid.

To effect this estimation of the true casein, the author recommends the method he described in 1896, but modified into two operations, to estimate and separate the true casein and the non-precipitable albumenoids in the cold with acetic acid. These two operations are as follows:—

First Operation.—Twenty-five c.c. of milk and 1 c.c. of a 30 per cent solution of neutral oxalate of potassium are put into a graduated matrass of 200 c.c. capacity; 20 c.c. of solution are added, prepared from 13·55 grms. of bichloride of mercury, 36 grms. of iodide of potassium, and water to make 1 litre; 2 c.c. of glacial acetic acid are added to the matrass, and water is added to 200 c.c.; shake well and filter. One hundred c.c. of the filtrate are then placed in a conical flask of 250 or 300 c.c. capacity, containing 10 c.c. of a solution of cyanide of potassium equivalent to a decinormal solution of nitrate of silver, and 15 c.c. of ammonia. By means of a burette, $\frac{1}{10}$th N solution of nitrate of silver is run in until the faint cloudiness is persistent. Let *a* be the number of tenths of a c.c. of this solution used, a number always greater than 48; from *a* subtract 48, and compare the figure thus obtained with the following table, which gives immediately in grms. per litre the total albumenoids contained in the milk:—

Values of *a*−48.	Albumenoids per litre.	Values of *a*−48.	Albumenoids per litre.
0	0	24	22·25
1	1	25	23·50
2	1·75	26	24·75
3	2·50	27	26
4	3·	28	27
5	3·75	29	28
6	4·50	30	29·25
7	5·50	31	30·75
8	6·50	32	32
9	7·15	33	33·50
10	8	34	35
11	9	35	37
12	10	36	39
13	11	37	40·50
14	12	38	42·75
15	13	39	45
16	14	40	47
17	15	41	49
18	16	42	51·50
19	17	43	54
20	18	44	57·20
21	19	45	60
22	20	46	62·50
23	21		

Second Operation.—To obtain the albumenoids not precipitable by acetic acid, we put into a 250 c.c. matrass 50 c.c. of milk, about 180 c.c. of water, and shake well; add 0·2 c.c. of glacial acetic acid, and water up to the 250 c.c. mark; shake well a second time and filter. We take 125 c.c. of this filtrate, which represents 25 c.c. of milk, put it in a 200 c.c. matrass, add 1 c.c. of a 30 per cent solution of oxalate of potassium, 20 c.c. of mercuro-potassic iodide, and 2 c.c. of glacial acetic acid; make up to 200 c.c. with water, shake well, filter, and finish the operation as above.

The new value, *b*, of the nitrate of silver used, still diminished by subtracting the constant 48, gives, by the aid of the table, the amount of albumenoids per litre of milk not precipitable by acetic acid.

Let A be the figure representing the total albumenoids in the milk under examination, and B the figure representing the albumenoids not precipitable by acetic acid; then A−B will give the proportion of "true" casein contained in 1 litre of milk. In the same way we might determine, after filtration, the albumenoids in the milk not coagulated by pressure, from which we could deduce the amount of proteic coagulate, which is of great importance in the manufacture of cheese.—*Revue Internationale des Falsifications*, 16th Year, Jan.-Feb., 1903, p. 18.

COMBUSTION IN GASEOUS MIXTURES OTHER THAN AIR.

By L. PELET and P. JOMINI.

In a previous paper (*Bull. Soc. Chim.*, 1902, p. 1207) we considered the causes of the extinction of flames in the air. In the present research we have endeavoured to find at what point the extinction of a flame takes place when a combustible material burns in a mixture of oxygen, nitrogen, and carbonic anhydride in variable proportions.

We have proceeded in these experiments as in the former ones, but we give the results of our analyses just as we obtained them, without reduction.

First Series.—In a bell-jar of 12 litres capacity, containing air previously charged with CO_2, we burnt a candle until it became extinguished. The analysis of the gas was made before and after combustion took place.

Air charged with—	The combustion lasted—	Gases estimated after combustion.		
CO_2, per cent.	Seconds.	CO_2, per cent.	O, per cent.	N, per cent.
2·5	90	4·3	16·5	79·2
3·5	60	5·4	16 2	78·4
6·2	12	6·9	17·0	76·1
8·0	8	8·3	17·3	74·4
10·8	1	10·8	17·0	72 2
11·8	0	11·8	17·0	71·2

Second Series.—Replacing the air charged with CO_2 by a mixture of oxygen and nitrogen.

Gases estimated before combustion.		Combustion lasted—	Gases estimated after extinction.		
O.	N.		CO_2.	O.	N.
Per cent.	Per cent.	Seconds.	Per cent.	Per cent.	Per cent.
20·8	79·2	120	3·6	16 0	80·2
25	75	150	6·0	17·0	77·0
30	70	225	8·4	17 6	74·0
40	60	300	27·8	19·5	52·7
50	50	360	32 0	20·7	47·3
60	40	370	33·0	20·7	46·1
65	35	370	34·1	20·7	45·3
70	30	380	34·9	20 6	44·5
80	20	380	50·0	21·2	27·9
90	10	380	52 0	21·1	26·0

Third Series.—We checked these results by burning a candle in mixtures of oxygen and carbonic anhydride.

Gases estimated before combustion.			Combustion lasted—	Gases estimated after extinction.		
CO_2.	O.	N.		CO_2.	O.	N.
Per cent.	Per cent.	Per cent.	Seconds.	Per cent.	Per cent.	Per cent.
40	21	39	0	40	21	39
65	22	13	1	65	21	14
50	36	14	100	60·2	20·8	19
25	75	0	300	78	22	—
50	50	0	120	78	22	—
65	35	0	90	78	22	—
70	30	0	60	78	22	—
75	25	0	0	75	25	—

From these figures it appears that a candle is able to burn in the presence of quantities of carbonic anhydride (less than 75 per cent) so long as 16 to 22 per cent of unburned oxygen remains in the gaseous mixture. We see that the different authors, who have stated that the extinction of the flame of a candle or petroleum lamp occurs at fixed proportions of carbonic anhydride, have only considered one aspect of the problem. On this subject we have found the following statements:—Eulenberg asserts that extinction occurs at 3 per cent of CO_2; Gaertner, at 2·2 to 7 per cent; Emmericb, at 8 per cent; Taylor, at 10 per cent; Graham-Otto, at 20 per cent; and Arnould, at 25 per cent. (*Journal für Gasbeleuchtung*, 1900, p. 335; 1901, p. 332; Graham-Otto, "Lehrbuch der Chemie," vol. ii., p. 719; Arnould, "Elements d'Hygiene," p. 179).

In his examination of the air of mines (*Ann. Chim. Phys.*, [3], 1845, xv., p. 488), Felix Leblanc was the only one, so far as we know, who has interpreted the facts in a correct manner. He says:—"It is the amount of oxygen that has disappeared that determines the resistance to combustion. At 17 per cent of oxygen (remaining) the combustion of lamps (of miners) is no longer sustained if the oxygen used has been replaced by its own volume of carbonic acid or by nitrogen."

We have completed the examination of this subject by using other combustible materials besides candles.

Fourth Series.—Combustion of an alcohol flame in air charged with carbonic anhydride in an enclosed space of 12 litres.

Air charged with—	Combustion lasted—	Gases estimated after extinction.		
CO_2, per cent.	Seconds.	CO_2, per cent.	O, per cent.	N, per cent.
4 0	8	6·7	14·3	79·0
6·5	4	6 8	14·4	78·8
7 0	6	7·2	15·3	77·5
11·4	1	11·4	15·4	74·0
13·3	0	13·3	15·3	71·4

Fifth Series.—Combustion of an alcohol flame in a mixture of oxygen and nitrogen in an enclosed space of 12 litres.

Gases estimated before combustion.		Combustion lasted—	Gases estimated after extinction.		
O.	N.		CO_2.	O.	N.
Per cent.	Per cent.	Seconds.	Per cent.	Per cent.	Per cent.
30	70	60	12·0	12·3	75·7
40	60	75	14·3	12 3	72·4
45	55	80	14·8	13·8	71·4
50	50	90	20·3	13·0	66·7

Sixth Series.—Combustion of lighting gas (butterfly flame) in air charged with carbonic anhydride.

Air charged with—	Combustion lasted—	Gases estimated after extinction.		
CO_2, per cent.	Seconds.	CO_2, per cent.	O, per cent.	N, per cent.
8·0	40	10·4	11·0	78·6
10·0	20	12·0	11·0	77·0
13·0	10	13 0	11·3	75·7
25·0	0	25·0	13·5	61·5

Seventh Series.—Combustion of lighting gas (butterfly flame) in a mixture of oxygen, nitrogen, and carbonic anhydride.

Gases estimated before combustion.			Combustion lasted—	Gases estimated after extinction.		
CO_2.	O.	N.		CO_2.	O.	N.
Per cent.	Per cent	Per cent.	Seconds.	Per cent.	Per cent.	Per cent.
0	40	60	40	13·0	10·9	75·2
0	50	50	42	12·5	11·2	75·5
0	55	45	50	14·8	10·7	74·5
0	60	45	50	14·8	11·2	74·5
24	40	36	50	34·4	11·2	54·4

We observe again that, whether in the combustion of alcohol or in that of gas, the flame is able to maintain itself in the presence of very variable quantities of carbonic anhydride, so long as there remains a certain proportion of unconsumed oxygen in the gaseous mixture.

In the case of alcohol, the minimal proportion of oxygen remaining was from 12 to 15·3 per cent; and in the case of lighting gas, from 10·7 to 12·5 per cent. For the present, we are not aware of the causes of the variations of the proportion of residual oxygen; the experimental material is, in fact, too much combined, and the different factors which determine the extinction of the flame too multiplex for us to attempt to apply the laws of chemical equilibrium in these preliminary researches.

In a general way, we may attribute the variations of the minimal proportion of remaining oxygen to the temperature of the flame, to the temperature of the air or gaseous mixture, and to the paralysing action of the carbonic anhydride formed in the reaction $C+O_2=CO_2$.

The changes of the flame before extinction give interesting data on the modifications of the combustion. As a general rule, the flames die out while becoming longer, smoking, and, what is very curious, when the combustion is taking place in the presence of a certain proportion of carbonic anhydride, the hydrogen of the hydrocarbonised products burns alone, forming water, and the proportion of carbonic anhydride formed increases very little or not at all. This fact is especially characteristic of the last experiment but one in the sixth series, where we see that the proportion of CO_2 is the same both before and after the combustion.

In the last experiment of the seventh series, the increase of carbonic anhydride is only apparent; it is caused exclusively by the disappearance of 30 per cent of oxygen converted into water vapour which was not estimated. Thus the combustion took place entirely at the expense of the hydrogen. We intend examining these various points more completely.

To sum up, we may state that:—

1. The combustion of a flame can be maintained in the presence of varying quantities of carbonic anhydride (from 0 to 75 per cent) so long as there remains a definite proportion of unburned oxygen in the gaseous mixture.

2. For the same combustion, the minimum proportion of unburned oxygen at which extinction occurs varies within small limits.

3. For different combustions, the proportion of residual oxygen corresponding to the extinction will be inversely proportional to the limit of combustibility (temperature of the flame, &c.).—*Bull. Soc. Chim.*, Series 3, vol. xxix., No. 5.

IMPROVEMENT IN THE USE OF SCHÖNBEIN PAGENSTECHER'S TEST-PAPER TO DETECT TRACES OF HYDROCYANIC ACID GAS.

By J. C. BRÜNNICH, F.C.S.,
Department of Agriculture, Brisbane, Queensland.

Schönbein Pagenstecher's test-paper was found very useful to prove the presence of hydrocyanic acid in some of our fodder plants—sorghum, maize, &c.—as a preliminary qualitative test in connection with the quantitative determination. An exhaustive investigation with fodder plants at various stages of growth is being carried out in the Departmental Laboratory by the author, in connection with the Director, Dr. W. Maxwell.

For the determination of the hydrocyanic acid the plants are quickly cut into slices, minced pretty fine, and mixed with weighed quantities of water in a well-stoppered bottle. After a very short time, under fermentative action, hydrocyanic acid is liberated, which is at once detected by the faint blue colouration on strips of the test-paper suspended from the stopper. The quickness and intensity of the colouration gives a fair guide to the quantity of the poison present in the plants. No hydrocyanic acid is liberated from the mixture if a small amount of formalin is added to the water, and the suspended test-paper remains perfectly white even after two or three days' standing. Thinking that perhaps formaldehyde vapours might interfere with the efficacy of the test-papers, I made a blank experiment to test the effect of formalin on the test-paper, and I found that it increases the sensitiveness of the paper enormously, and that if the Schonbein Pagenstecher's test-papers are moistened with formalin, instead of using water, the presence of the faintest traces of HCN produces instantly a deep blue colour on the papers; this colour differing from the light blue produced if the papers are moistened with water. The blue colour fades slowly, disappearing finally, if the paper is exposed to the air, but is again reproduced by the presence of HCN.

Fumes of concentrated nitric acid and of bromine produce a similar colour, the blue changing into a yellowish and greenish tint after longer exposure.

Other liquids were used to moisten the test-papers, and I found that alcohol and ether act similarly to formalin, although not so intensely, whereas chloroform and turpentine have the same effect as water in producing the faint blue only in the presence of hydrocyanic acid gas.

ON CERIC CHROMATE.*

By PHILIP E. BROWNING and CHARLES P. FLORA.

Böhm (*Zeit. Angew. Chem.*, xv., 1282) in a recent paper descriptive of his thorough investigations of the application of chromic acid to the separation of the cerium earths, states that when the mixed oxides of cerium, lanthanum, and didymium are brought in contact with a calculated amount of chromic acid, a little water added, and heat applied for a time, an orange-red amorphous powder remains which proves to be a basic ceric chromate. In connection with a study of the methods of separating the cerium earths, begun last summer, we had occasion to make an experiment similar to that described by Böhm, differing possibly in this respect—that we used a decided excess of the chromic acid (100 grms. of the oxides with 150 grms. of chromic acid and 200 c.m.³ of water).

The product which we obtained was a bright scarlet crystalline salt, which, when washed sparingly with water and dried over sulphuric acid, became a little darker in colour, but retained its crystalline condition. Examined under the microscope, the salt appeared homogeneous, and the crystalline form orthorhombic, the prevailing habit being prismatic, $m \wedge m'''$, $110 \wedge 1\bar{1}0$, being approximately 58° C. The macropinacoid, *a* (100), is generally present; the brachypinacoid, *b* (010), is well developed; and a flat brachydome and the basal plane, *c* (001), are the terminating forms. The crystals are etched or pitted, are slightly pleochroic, and exhibit parallel extinction and low birefringence. When treated with water, the salt loses chromic acid and becomes an orange-yellow. It may be heated to about 150° C. without loss of weight. Between 150° and 180° C. it loses water and becomes

* Contributions from the Kent Chemical Laboratory of Yale University. From the *American Journal of Science*, [4], vol. xv., No. 87.

brownish red, still retaining much the same original exterior form. Above 180° C. it decomposes. It is quite readily soluble in dilute acids, especially sulphuric acid, and is easily decomposed by potassium or sodium hydroxide into the alkali chromate and ceric hydroxide. The ceric hydroxide thus formed is quite readily soluble in acids, and promises to be a convenient starting point for the preparation of ceric salts. Qualitative tests proved the absence of both yttrium and didymium.

Analysis of the salt gave the following results :—Five closely agreeing determinations of water, six determinations of ceric oxide, among which the greatest variation was about 1 per cent, and sixteen determinations of chromic acid showing as the greatest variation about 2 per cent, gave the averages tabulated below :—

	Salt examined.	$Ce(CrO_4)_2 2H_2O$ calculated.
CeO_2	41·94	42·14
CrO_3	49·61	49·04
H_2O	8·82	8·82
	100·37	100 00

From these analyses we feel justified in assuming the crystalline salt to be a close approximation to a compound whose constitution would be expressed by the symbol $Ce(CrO_4)_2 2H_2O$.

The material from which the mixed oxides used in this work were obtained was a mixture of sulphates of cerium, lanthanum, and didymium, carrying a trace of yttrium.

The authors are indebted to Mr. J. C. Blake for the crystallographic examination.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Wednesday, March 18th, 1903.

Prof. J. EMERSON REYNOLDS, Sc.D., F.R.S., President, in the Chair.

MESSRS. J. M. Wadmore, J. Phelps, and F. Soddy were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Wm. Lester St. John Alton, Dungarvan, Putney Heath, S.W.; Henry Gough, c/o Messrs. J. Lovibond and Sons, Ltd., Greenwich, S.E.; William Kirkby, Winster House, Thornfield Road, Heaton Moor; John George Collcutt Lock, 17, Berners Street, W.; George G. Pond, M.A., Ph.D., State College, Pennsylvania, U.S.A.; Robert James Porter, 11, Arlington Street, Hull; Ernest William Sawdon, B.Sc., 2, Esk Terrace, Whitby; Giles Hadden Welsford, 6, The Orchard, Blackheath, S.E.

The PRESIDENT stated, in reference to a petition which had been recently presented to the Council, that he had the authority of the Council to communicate to the Society the terms of the petition and of the resolution of the Council with regard to it. The terms of the petition were :—

> "We, the undersigned Fellows of the Chemical Society, being of opinion that the interests of the general body will be promoted by limiting the period of service of the Honorary Secretaries and Foreign Secretary, do hereby request the Council to earnestly consider the desirability of so limiting the tenure of office."

The resolution passed by the Council *nem. con.*, which was duly communicated to Mr. C. E. Groves, who represented the petitioners, was "That this Council is of opinion that the tenure of office of the Officers of the Society should not be indefinitely extended, but that it is not desirable to limit the period by assigning a definite term of years to the tenure of each office."

Of the following papers, those marked * were read :—

*45. "*Essential Oil of Hops.*" By A. C. CHAPMAN.

Since the publication of the earlier results of the study of oil of hops (*Proc.*, 1893, 177; *Trans.*, 1895, lxvii., 54 and 780), three more samples of oil of undoubted genuineness have been examined. These had the following specific gravities and specific rotations :—

	Sp. gr. 15°/15°.	Sp. gr. 20°/20°.	$[\alpha]_D$ 20°.
No. 5	0·8676	0 8645	+0·30°
No. 6	0·8639	0·8610	−0·20°
No. 7	0·8403	0·8357	−0·08°

The fraction of lowest boiling-point, obtained after prolonged fractional distillation under reduced pressure, consisted of a hydrocarbon $C_{10}H_{16}$, which had the following properties :—Sp. gr. 0·8046 at 15°/15° and 0·8020 at 20°/20°; b. p. 74—75° (33 m.m.) and 166—168° (774 m.m.), undergoing at the same time slight polymerisation. It was optically inactive, and had a refractive index 1·4645 at 20°, and a molecular refraction 46·8, the calculated number for $C_{10}H_{16}$ (with 3 double linkings) being 46·78. This compound is therefore an aliphatic hydrocarbon, and its properties are almost identical with those of myrcene; it absorbs oxygen from the atmosphere, and readily undergoes polymeric change, becoming converted into a colourless resin.

The next fraction (b. p. 120—130°, 46 m.m.) was a very small one, and gave on analysis numbers agreeing with the formula $C_{10}H_{18}O$. It had a sp. gr. 0·8571 at 20°/20°, produced a rotation of −0° 40′ in a 100 m.m. tube, and evidently consisted of inactive linalool mixed with a small quantity of some active substance.

The third small fraction (b. p. 135—150°, 46 m.m.) consisted of an ester, and yielded on saponification *iso*nonoic acid, $C_9H_{18}O_2$, and linalool, together with a small quantity of geraniol.

The highest and largest fractions in all three samples of oil consisted of nearly pure humulene. On submitting the oil to the action of boiling chromic acid mixture, it yielded acetic, valeric, succinic, unsymmetrical dimethylsuccinic (m. p. 140°), and *iso*nonoic acids, the last of these having been probably derived from the linalyl ester. When dilute nitric acid was employed in the oxidation, oxalic and acetic acids were the chief soluble products of acidic character.

Oxidation experiments made with the fractionated constituents of the oil showed that the dimethylsuccinic acid is derived from the humulene, and succinic acid from the myrcene.

The essential oil of hops therefore contains the following compounds :—Myrcene, humulene, linalool, linalyl *iso*nonoate, with small quantities of a diterpene, and probable traces of some ester of geraniol.

In all the freshly distilled samples of oil examined, the hydrocarbons myrcene and humulene were present to the extent of from 80 to 90 per cent.

DISCUSSION.

Dr. POWER remarked that the results obtained by Mr. Chapman seemed to leave no doubt respecting the identity of the hydrocarbon of low boiling-point contained in hop oil with the myrcene of oil of bay. Attention was also called to the fact that, apart from the interest connected with the general properties of myrcene and the occurrence of such an olefinic terpene in nature, it has recently been utilised in a study of the chemical composition of Para rubber. Harries (*Ber.*, 1902, xxxv., 3259) has shown that when rubber is treated with nitrous acid it yields a series of nitrosites, one of which has the molecular composition $(C_{10}H_{15}O_7N_3)_2$, and appears to be identical in every respect with a nitrosite obtained from a product of the polymerisation of myrcene termed dimyrcene, $C_{20}H_{32}$. It is thus rendered probable that myrcene stands in very close relationship to isoprene and caoutchouc.

In reply to Professor Tilden, Mr. CHAPMAN said that he

had not obtained any evidence of the existence of pinene in the oil. The slight optical activity was, in all probability, due to the presence of a small quantity of active linalool, but the intermediate fractions were so small, even when working with considerable quantities of the oil, that it was impossible to arrive at a definite conclusion in regard to this point.

*46. "*A Compound of Dextrose with Aluminium Hydroxide.*" By A. C. Chapman.

The author has obtained a compound of dextrose with aluminium hydroxide by the following process:—

To a solution of 8 grms. of pure anhydrous aluminium chloride in about 1500 c.c. of 90 per cent alcohol, powdered dextrose was added until it no longer dissolved after allowing the mixture to remain some time in a warm place. The white, gelatinous precipitate immediately produced by adding aqueous ammonia in slight excess to the filtered solution was collected, washed with 90 per cent alcohol, and dried until of constant weight in an exhausted desiccator over sulphuric acid. It was not found possible by repeated washing to remove the last trace of chlorine, a small quantity invariably remaining, apparently in the form of a basic chloride. By careful treatment it is, however, possible to obtain a preparation which, after drying, will not contain more than 0·2 to 0·5 per cent of chlorine.

Many different preparations of this compound were made with slightly varying proportions of dextrose and aluminium chloride. The analytical results, although fairly concordant, do not correspond with any simple formula:—

	C=	H=
1. 0·6010 gave 0·376 CO_2 and 0·276 H_2O.	17·06;	5·10.
2. 0·4270 „ 0·275 CO_2 „ 0·196 H_2O.	17·56;	5·08.
3. 0·4135 „ 0·264 CO_2 „ 0·185 H_2O.	17·41;	4·96.
4. 0·6010 „ 0·250 Al_2O_3; Al=22·01.		

Three other estimations gave Al=22·12, 22·18, and 22·34.

$[3C_6H_{12}O_6,5Al_2O_3,11H_2O]$ requires C=17·39; H=4·67; Al=21·80 per cent.

From these results, it appears probable that the white, flocculent precipitate is a compound of 3 mols. of dextrose with 5 mols. of aluminium hydroxide $[3C_6H_{12}O_6,5Al_2(OH)_6]$, and that this compound, when dried, in an exhausted desiccator over sulphuric acid, loses approximately 4 mols. of water (compare *Trans.*, 1889, lv., 576; 1891, lix., 224).

This aluminium compound is a white, amorphous substance, insoluble in water and alcohol, but dissolving in dilute acids. It differs from the similar compounds of dextrose with the oxides of iron and chromium in being insoluble in water when freshly precipitated; with boiling water it undergoes partial decomposition into aluminium oxide and dextrose. On drying for some hours at 100°, the substance lost 12 per cent of its weight, and acquired a pale yellow colour, but did not char appreciably at this temperature; it burned with extreme readiness when heated more strongly, yielding a mixture of the metallic oxide mixed with carbon, the final residue after prolonged ignition consisting of aluminium oxide.

*47. "*Action of Phosphorus Haloids on Dihydroresorcin.* Part II. *Dihydroresorcin.*" By A. W. Crossley and P. Haas.

Dihydroresorcin behaves towards phosphorus haloids in a similar way to its dimethyl derivative (*Trans.*, 1903, lxxxiii., 110), in fact, as if it possessed the following formula:—$CH_2<\begin{matrix}CH_2\text{—}CO\\CH_2\cdot C(OH)\end{matrix}>CH$.

5-Chloro-3-keto-Δ^4*-tetrahydrobenzene*,—

$$CH_2<\begin{matrix}CH_2\text{—}CO\\CH_2\cdot CCl\end{matrix}>CH,$$

obtained by the action of phosphorus trichloride on dihydroresorcin, is a colourless, highly refractive liquid boiling at 104° (24 m.m.); it gives a *semicarbazide* melting at 190°, and on oxidation is converted into glutaric acid.

The corresponding *bromo*-derivative boils at 132·5—133° (52 m.m.).

Phosphorus pentachloride gave rise to 3:5-*dichloro*-Δ^2:4-*dihydrobenzene*, $CH_2<\begin{matrix}CH=CCl\\CH_2\cdot CCl\end{matrix}>CH$, a colourless refractive liquid boiling at 88—90° (29 m.m.). On treatment with excess of phosphorus pentachloride or with bromine, it was converted into *m*-dichlorobenzene, and on reduction with sodium in moist ethereal solution, yielded a mixture of di- and tetra-hydrobenzenes. This mixture of hydrocarbons readily absorbed two atoms of bromine, and the resulting liquid deposited crystals of *dibromodihydrobenzene*, $C_6H_8Br_2$, which separated from light petroleum in transparent, hexagonal prisms melting at 104·5°, and decomposing at 170° with evolution of hydrogen bromide.

*48. "*The Constitution of Cotarnine.*" By J. J. Dobbie, A. Lauder, and C. K. Tinkler.

Although previous investigators are in agreement as to the possible existence of the carbinol form of cotarnine, the question as to whether this constitution or one expressed by an open change formula should be assigned to solid cotarnine has hitherto remained unsettled. A satisfactory answer has now been furnished by the study of the absorption spectra of this substance and its derivatives. Solid cotarnine begins to undergo a constitutional change as soon as it comes into contact with water or alcohol, but is not altered either by ether or chloroform, and the spectra of the ethereal and chloroform solutions, which may therefore be regarded as the true spectra of cotarnine, agree perfectly with one another, and also with those of hydrocotarnine and its salts; moreover, they are identical with those of the cyanide and ethoxyhydrocotarnine, these substances having been regarded as derivatives of the carbinol form.

The spectra of dilute aqueous or alcoholic solutions of cotarnine and those given by a solution of cotarnine hydrochloride from which the chlorine has been removed by means of silver oxide, are almost identical with the spectra of cotarnine hydrochloride, which, on the other hand, differ widely from the spectra of cotarnine in ether.

Cotarnine and all its derivatives hitherto examined spectroscopically conform to one or other of these two forms of spectra. (i.). The spectra of cotarnine in aqueous or alcoholic solution and of cotarnine salts show a large amount of general absorption with two well-marked absorption bands, one of which is close to the visible region. (ii.). The spectra of cotarnine in ether or chloroform, hydrocotarnine, ethoxycotarnine, and cotarnine cyanide show less general absorption than the former, and have a band much further removed from the visible region.

The substances in the first class are yellow, those in the second are colourless; the latter can all be represented as having a carbinol constitution.

When cotarnine is dissolved in anhydrous alcohol, it changes from the carbinol to the quaternary ammonium hydroxide form,—

$$C_8H_6O_3<\begin{matrix}CH(OH)\cdot NMe\\CH_2\text{——}CH_2\end{matrix} \rightarrow C_8H_6O_3<\begin{matrix}CH=NMe\cdot OH\\CH_2\cdot CH_2\end{matrix},$$

the re-arrangement being promoted either by increasing the mass of the alcohol present or by heating. The transformation is effected much more rapidly by methyl than by ethyl alcohol.

A colourless solution of cotarnine in alcohol cannot be obtained, but since this isomeric change proceeds slowly, it is possible in ethyl alcohol, by photographing the freshly prepared solution immediately, and again after successive intervals of time, to trace the transformation through all its phases. The rate of progress of the change may even be determined by comparing photographs of the alcoholic solution with those of the spectra of mixtures of the solutions of the hydrochloride (ammonium form) and the cyanide (carbinol form) in known proportions. Potassium, sodium, and barium hydroxides, and even ammonia,

promote the reverse change to that effected by alcohol. When cotarnine hydrochloride in solution is decomposed by sodium hydroxide, the cotarnine changes at once to the carbinol form, but if an aqueous solution of cotarnine is treated with successively larger quantities of this alkali, the reverse change is gradual, and, as in the case of the opposite change induced by alcohol, can be distinctly traced through its various phases. These results explain several of the peculiarities observed by Hantzsch and Kalb (*Ber.*, 1899, xxxii., 3109) in their experiments on the conductivity of cotarnine.

Preliminary experiments indicated that similar results are given by hydrastinine.

DISCUSSION.

Mr. BALY said that an interesting comparison could be drawn between these absorption spectra of cotarnine compounds and those obtained by Hartley and Dobbie with derivatives of *o*-oxycarbanil. In the latter case, the lactam esters correspond to the derivatives from the ammonium hydroxide form of cotarnine, and the lactim esters to the derivatives from the carbinol form. The absorption spectra of the lactim esters of *o*-oxycarbanil and of the ammonium hydroxide form of cotarnine, both have more general absorption with the absorption band nearer to the visible region than in the case of the spectra of the lactim esters of *o*-oxycarbanil and the carbinol form of cotarnine. This contrast appears to be the opposite of that observed in the keto and enolic forms of carbon compounds.

Dr. ORTON asked whether the addition of a small quantity of alcohol to the ethereal solution of cotarnine, in which the alkaloid was present in the carbinol (or pseudo-ammonium) form, effected a *complete* conversion of the carbinol into the true ammonium base; or was, on the other hand, a point of equilibrium reached which was only displaced by addition of a further quantity of alcohol? As the presence of small quantities of bases such as piperidine has such a marked influence on similar isomeric changes, preventing the change of a non-basic into a basic substance, and facilitating the reverse process, it would be of interest to know whether any similar observations on the transformation of cotarnine under the influence of alcohol has been made.

In reply to Mr. Baly, Prof. DOBBIE stated that no such general relation between the absorption spectra of lactams and lactims, as seemed to be implied in the question, had been established.

With reference to Dr. Orton's question, he stated that the amount of change produced by sodium hydroxide in an aqueous solution of cotarnine was found to be proportional to the quantity of caustic alkali added, when the solution was examined immediately after the addition of this reagent. The effect of time on the alkaline solution had not yet been fully investigated.

*49. "*Decomposition of Mercurous Nitrite by Heat.*" By P. C. RAY and J. N. SEN.

When mercurous nitrite was decomposed by heat in a tube connected with a Sprengel pump, nitric oxide escaped mixed with very little nitrogen peroxide, crystals of mercurous nitrate were projected across the upper and cooler part of the tube, just over the decomposing salt, a very little metallic mercury and its basic nitrate were deposited at the sides, whilst a small quantity of amorphous, orange-coloured mercuric oxide was left in the place of the decomposed nitrite. Except when the greater portion of the nitrate which had formed at first had been decomposed by heating more strongly, the average amount of nitric oxide produced corresponded with only 3·3 out of the 5·7 per cent of nitrogen contained in the nitrite.

The production of mercurous nitrate was evidently due to interaction between nitrogen peroxide and mercury vapour, nitric oxide being the other product. In decomposing, the mercurous nitrite behaves partly as if it had a non-oxylic constitution in yielding mercury and nitrogen peroxide, and partly as if it had an oxylic constitution in giving rise to mercuric oxide and nitric oxide.

DISCUSSION.

Dr. DIVERS said that the authors' observation of the conversion into crystals of mercurous nitrate of the nitric peroxide and mercury vapour coming from the mercurous nitrite was very interesting, and recalled the production of crystals of mercurous chloride from a mixture of mercury vapour, air, and hydrochloride acid, which occurred in the manufacture of that substance in the old Japanese way. It also strikingly confirmed, as the authors had pointed out, the accuracy of the account of the decomposition of silver nitrite given by Shimidzu and himself years ago. He considered the authors to be mistaken as to the origin of the small quantity of mercuric oxide which was always produced. That this formed just where the mercurous nitrite had lain was not that the nitrite had directly decomposed into mercuric and nitric oxides, but that, by the use of a small flame as applied, this spot was the only part of the tube sufficiently hot to bring about the well-known decomposition into this oxide of the mercurous nitrate which was forming out of the gas and vapour, equally and as much here as in the upper and cooler part of the tube.

50. "*The Action of Nitrogen Tetroxide on Pyridine.*" By J. F. SPENCER.

In attempting to nitrate pyridine, the author studied the action of nitrogen tetroxide on this base, and although nitropyridine was not isolated an isomeride was produced. The nitrogen tetroxide, which was prepared by the direct combination of nitric oxide and oxygen, was employed either in the gaseous form or as a liquid at low temperatures; but these variations of the experimental conditions did not materially affect the course of the reaction, which gave rise to the same product whether the base was treated alone or in the presence of various solvents.

The first product is an unstable, white crystalline compound which was shown by analysis to be an additive compound of pyridine and nitrogen tetroxide. The further action of the latter reagent led to the production of a solid, black substance, which, when treated with water, entirely dissolved, yielding a brownish-red solution; this solution, on further dilution, gave a yellow, amorphous deposit (i.) amounting to about 4 per cent of the pyridine taken. The filtrates, when rendered alkaline, furnished 70 per cent of unaltered pyridine, but no other basic substance. If, however, the alkaline solution was acidified, it gave a purplish-brown precipitate (ii.), the composition of which was not determined.

(i.). The yellow product, which is insoluble in all the ordinary organic solvents except pyridine, dissolves in mineral acids or aqueous alkalis, forming deep red solutions; when rapidly heated, it decomposes explosively at 234°; on distillation with zinc dust, it yields pyridine:—

0·1986 gave 0·3530 CO_2 and 0·0568 H_2O. C = 48·66, H = 3·19.

0·0691 gave 13·44 c.c. moist nitrogen at 13° and 764·6 m.m. N = 22·77.

$C_5H_4O_2N_2$ requires C = 48·38, H = 3·22, N = 22·58 per cent.

These results were confirmed by many additional analyses. The hydrochloric acid solution of this substance yielded a platinichloride containing 13·53 per cent Pt. Calculating the molecular weight of the polymeride from this result, the value 521 is obtained; this corresponds with the molecular formula $(C_5H_4O_2N_2)_4$, which has a molecular weight 496. All attempts to depolymerise this substance failed; mild reducing agents had no action, although tin and hydrochloric acid reduced it to a basic compound, the platinichloride of which contained 31·49 per cent Pt, whilst $(C_5NH_4{\cdot}NH_2)_2H_2PtCl_6$ requires 32·6 per cent Pt.

(ii.). The purple substance somewhat resembles the yellow compound, but is evidently more complex.

The unsatisfactory yields and the highly complex nature of the products have rendered it impossible to pursue this investigation.

PHYSICAL SOCIETY.

Ordinary Meeting, March 27th, 1903.

Dr. R. T. Glazebrook, F.R.S., President, in the Chair.

A paper "*On Refraction at a Cylindrical Surface*" was read by Mr. A. Whitwell.

The object of the paper is to describe and illustrate the position and form of the focal areas produced by the refraction, at a cylindrical surface, of light diverging from or converging to a point. In general, if a plane can be drawn through the point to cut the surface symmetrically, then all the light passes really or virtually through an area in this plane. In the case of the cylinder there are two such planes. One contains the radiant point and the axis of the cylinder; the other contains the point, and is normal to the axis. The equation of the locus of intersections of symmetrical rays which intersect in the first plane, for small apertures, is obtained in terms of a, the distance of the radiant point from the axis of the cylinder, r the radius, and μ the index of refraction. A set of curves is plotted for various values of a from $+\infty$ to $-\infty$, r being taken as 2 and μ as $\frac{3}{2}$. A similar equation is found for the locus of intersection of symmetrical rays which intersect in the first plane and have a maximum angle of incidence, viz., $\frac{\pi}{2}$. A set of curves for various values of a is plotted and discussed. For any particular value of a a curve from each of these two sets is the limit of the focal area, and all the light passes through the area between these curves. Two other sets of curves are plotted for various values of a, r being $= 2$ and $\mu = \frac{2}{3}$. The loci of the intersections of symmetrical rays which intersect in the second plane, when the aperture is small, are shown to be circles described about the radiant point as centre and having radii equal to $(\mu-1)(a-r)$. In general a surface has two powers, and two powers only. Attention is called to misleading statements in two papers on this subject read before the Society recently. The authors of these papers give expressions for the power of a cylindrical or ellipsoidal surface in various directions, the expressions being deduced from a consideration of the curvature of the section of the surface by a plane containing the optic axis and inclined at various angles to the two planes considered in the present paper. These oblique powers are purely fictitious.

Prof. Everett said he had had an opportunity of studying the paper, and found the reasoning sound. He was pleased that the author had taken up the subject of focal lines rigorously, and had made no preliminary assumptions about them. The focal lines referred to in the paper were the secondary focal lines. The primary lines were only introduced near the end as caustics. Prof. Everett also indicated the cause of the false focal lines given by the author's equations. Referring to Mr. Whitwell's criticism regarding the power of an oblique section of an ellipsoidal lens, he thought that although the power was fictitious and the criticism just, there was something to be said for the advantage of using these powers in deducing the properties of lenses.

The Chairman said he agreed with Prof. Everett in his remarks concerning the rigorous treatment of the secondary focal lines.

Dr. R. A. Lehfeldt read a paper on "*The Evaluation of the Absolute Scale of Temperature.*"

The relation governing the indications of the constant-pressure thermometer is—

$$\frac{dT}{T} = \frac{dv}{v\left(1 - \frac{K_p \epsilon}{v}\right)},$$

where T = absolute temperature, K_p = specific heat at constant pressure, and $\epsilon = -\frac{\delta T}{\delta p}$, the Joule-Thomson effect. The relation for the constant-volume thermometer is—

$$\frac{dT}{T} = \frac{dp}{p\left(1 - \frac{K_p \epsilon}{v} + \frac{1}{v}\frac{\partial_T \psi}{\partial p}\right)}$$

or—

$$\frac{dT}{T} = \frac{dp}{p\left(1 - \frac{K_p u}{p}\right)}$$

where $\psi = pv$ and $u = \frac{\delta T}{\delta v}$ the Joule effect. An attempt is made to work out the latter formula with the aid of existing data. It is found that $T_0 = 273{\cdot}18$ from hydrogen and $273{\cdot}2$ from nitrogen. The deviation of the constant-volume scale from the absolute scale is indicated by curves. At 100° absolute the constant-volume (hydrogen) thermometer reads 0·1 or 0·2 too low.

Prof. Callendar, in a communication sent subsequent to the meeting, said that in his paper on "The Thermodynamical Correction of the Gas Thermometer" (*Phil. Mag.*, Jan., 1903) he had incidentally mentioned that the correction for the constant-volume gas-thermometer could not be directly deduced from the Joule-Thomson cooling-effect alone, without additional data for the value of $d(pv)/dp$, unless a formula were assigned for the variation of the cooling effect with temperature; but that the value of the absolute zero could be deduced from the pressure coefficient if the Joule cooling-effect in free expansion ($dE=0$) were known. The experimental measurement of the latter was, however, impracticable. He also wished to draw attention to his method of treating these and similar problems in terms of the diminution of volume, c, of a gas due to coaggregation of the molecules. This was a method of great practical convenience, because c was to a first approximation a function of the temperature only, whereas the capillary pressure a/v^2 of Van der Waals was a function of both temperature and pressure. The method was based on a radically distinct conception of the nature of the deviation of gases from the ideal state, as being due to the formation of temporary molecular aggregates, and not to the existence of a general molecular attraction varying as the square of the density and analogous to capillary pressure. The theory showed that different types of molecules should coaggregate in different ways, and that the law of corresponding states as usually interpreted was subject to important limitations.

Mr. Blakesley exhibited and described a Lens possessing the following properties:—

The two conjugate foci always move with the same relative rate along the axis. The size of the object always bears to the size of the image the same ratio, so that using the same object the image is always of the same size. The instrument is of one piece of glass, and constitutes a telescope whose magnifying power is the ratio which the object bears to the image in size, linear. The relation of the rate of motion of the object to that of the image is the square of the magnifying power. The following method of construction attains these ends:—Let D be the distance between the centres from which the faces are struck, and let l be the length of the instrument between the end faces. Then $l = \mu D$ where μ is the index. The quantity $l - D$ is thus fixed. Divide it into any two parts (algebraically) r_1 and $-r_2$, so that $r_1 - r_2 = l - D$, and employ these two values r_1 and r_2 as the radii of the end faces. The ratio r_1/r_2 will be the magnifying power m, which must be interpreted thus:—If the curvatures are towards the same direction, r_1 and r_2 have the same sign and m is positive. Double convexity therefore implies an inversion of the image, or a negative magnifying power.

If x be the distance of the object from the first surface encountered by the light, and y be the distance of the image from the second surface, both measured positively in the direction opposite to that of light-propagation, then—

$$ym^2 - mD = x \text{ where } m = \frac{r_1}{r_2},$$

from which—

$$\frac{dx}{dy} = m^2.$$

The fundamental condition $l = \mu D$ is that which implies an infinite focal length for a lens. This condition rules in a telescope in which the principal foci of the objective and ocular coincide. The instrument exhibited had a value +5 for the magnifying power, and was convexo-concave accordingly. Mr. Blakesley pointed out that one view to take of the instrument was to imagine the space between an objective and ocular properly situated, filled up with glass.

NOTICES OF BOOKS.

Quantitative Chemical Analysis. Adapted for Use in the Laboratories of Colleges and Schools. By FRANK CLOWES, D.Sc. (Lond.), &c., and J. BERNARD COLEMAN, A.R.C.Sc. (Dublin). Sixth Edition. London: J. and A. Churchill. 1903. Pp. 602.

THE successive editions of this book, following each other at intervals of two or three years, afford ample evidence of its value. In the present edition further alterations and improvements have been made; the section on Organic Chemistry has been revised, and processes for the determination of molecular weights by the elevation of the boiling-point, and others for the analysis of aluminium alloys have been added. New woodcuts have been introduced, as well as tables of four-figure logarithms; with regard to the latter innovation, we are not much in favour of these short tables—the present one covers but four pages; anyone in the habit of using logarithms would naturally have a book containing them on a much more extended scale.

In the section on Water Analysis, we see that the reader is referred to "Frankland's Water Analysis," or "Sutton's Volumetric Analysis," for the description and practice of the former's beautiful method for the estimation of the organic matter in water. True it is that the proper working of this method requires a good deal of skilful manipulation and constant practice, but still we think it is a pity that the authors have not given at least a description of this method, which is at once the most accurate and most valuable one used in water analysis.

Emery Grinding Machinery: a Text-book of Workshop Practice in General Tool-grinding, and the Design, Construction, and Application of the Machines Employed. By R. B. HODGSON, A.M.Inst.Mech.E. With 143 Illustrations. London: Charles Griffin and Co., Ltd. 1903. Pp. 180.

EMERY grinding has developed to a remarkable extent during recent years, and in many modern engineering shops has to all intents and purposes superseded planing and shaping machines, but the general manufacturer in metal working does not appear to have taken full advantage of the use of the emery wheel. It is to encourage the more extended use of this class of machinery that the author has compiled the volume now before us.

In these pages will be found descriptions and illustrations of a remarkably full and varied collection of emery-grinding tools and machinery.

Emery wheels can be obtained of varying degrees of coarseness according to the work to be done, the size of the grains being denoted by the number of meshes per inch of the sieve the powder passes through, from 30 to 200; finer sizes are separated and numbered according to the time they take to settle in water; for instance, ten-minutes emery means emery which will settle in ten minutes after having been shaken up with water.

The difficulties which formerly attended the making of emery wheels has now been overcome, and excellent ones are made by the vitrified process, in which the wheels are subjected to intense heat.

The usual peripheral speed for an emery wheel is 5000 feet per minute, but there are cases in which a higher or lower speed is advisable; a useful table of speeds and sizes will be found on page 22.

The book, which is divided into thirteen chapters, deals with emery grinding in all its branches, and may be fairly described as a work of a thoroughly practical character; it is well printed, and the index is an adequate one.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. CXXXVI., No. 11, March 16, 1903.

Solidification of Fluorine. Combination at −252·5° of Solid Fluorine and Liquid Hydrogen.—H. MOISSAN and J. DEWAR.—In a previous research the authors proved that fluorine liquefies at −187°, and at this temperature has no action on crystalline silicon, amorphous carbon, boron, and mercury. In fact, that its chemical affinities were weakened in all cases except with hydrogen, for it combines with this gas or with solid essence of terebenthine with incandescence. At this temperature in the present investigation the authors place a bulb of fluorine in liquid hydrogen, and observe it first liquefying and then solidifying to a yellow mass, which at a temperature of 20·5° absolute becomes white. Various experiments lead to the conclusion that fluorine solidifies at about 40° absolute. They also find that at 20·5° absolute this body reacts with liquid hydrogen with great violence.

Theory of Steel Tempering.—André Le Chatelier.—The author believes that the tempering of steel should be considered as the result of a strain produced by the variations of volume during the transformations, variations whose value increases with the rapidity of cooling, on account of the special coefficient of dilatation which steel possesses above the zone of transformation. The part played by carbon in the tempering is that it facilitates the lowering of the transformation zone and also it increases the intensity of the special tension which is produced above 100°. An investigation of the transformation which this characteristic tension allows is probably a means of explaining the part played by carbon and its state in steels.

Combination of Plumbic Acid with the Organic Acids.—Albert Colson.—The author obtains a new class of bodies resulting from the union of the fatty acids with normal plumbic acid, $Pb(OH)_4$, by a method which has no analogy with that of Gerhardt, the application of this latter having proved impossible in these cases.

Heat of Transformation of White Phosphorus into Red.—H. Giran.—As a result of numerous experiments the author finds that the transformation of white into red phosphorus evolves about +4 cal. This result agrees as nearly as possible with theoretical prediction. When red amorphous phosphorus is transformed into crystalline violet phosphorus, about +0·5 cal. is evolved, results which have led many chemists to believe that these two

varieties are identical. The author's results are within the limits of possible experimental error, so he cannot come to any definite conclusion on the subject.

Cellargol.—M. Hanriot.—The author investigates the substance formed during the reduction of silver nitrate with ferrous sulphate.

Action of Metals on Hot Fatty Acids.—A. Hébert. The fatty acids when acted upon at a high temperature by the more oxidisable metals, are first transformed into ketones, which are decomposed in their turn, giving rise chiefly to carbon dioxide, hydrogen, and various ethylenic carbides, first giving products of degradation and then products of polymerisation of the carbides corresponding to the acids employed.

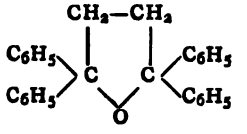
Properties of a Solution of Sodium Sulphate.—C. Marie and R. Marquis.—The authors' examination of solutions of sodium sulphate show that between the limits considered, which certainly include the transformation temperature of the salt and under the experimental conditions chosen, there is no sudden variation in the properties of the solution. It is seen, therefore, once more that there is no reason to think that in solution the salt exists with the molecules of water which make an integral part of the crystalline molecule, considered at the same temperature as the solution.

A New Method of Preparation of Plumbico-ammoniacal Chloride.—A. Seyewetz and P. Trawitz.—The authors modify Friedrich's method for the preparation of plumbico-ammoniacal chloride, by replacing the action of a current of chlorine by that of chlorine obtained from ammonium persulphate and hydrochloric acid. By this means they have no need to add ammonium chloride, as the ammonia of the persulphate serves to form the ammonium chloride necessary for the production of the double salt.

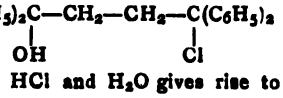
Diaminoethenic Compounds of Cadmium.—Ph. Barbier.—When a concentrated solution of diaminoethene, $C_2H_4(NH_2)_2H_2O$, is added to a moderately concentrated solution of cadmium iodide a white precipitate is formed, which re dissolves on the addition of an excess of the reagent. The clear liquid filtered and kept for a little time deposits transparent needles having formula $CdI_2,4C_2H_4(NH_2)_2$. This compound, which the author calls cadmium tetradiaminoethene iodide, is only stable in its own mother-liquor. When water is added the crystals become opaque and crumble to a powder. From this the substance, $2CdI_2,4C_2H_4(NH_2)_2$, can be prepared.

Methylation and Condensation of Ethyl Glutaconate.—E. E. Blaise.—The methylation of ethyl glutaconate under the simplest conditions, *i.e.*, at 0°, gives a dimethylglutaconic ether boiling at 130° under 14 m.m. The author investigates this reaction, which is of a very complex nature.

Tetraphenylbutanediol and its Products of Dehydration.—Amand Valeur.—The dehydration of tetraphenylbutanediol takes place between the two tertiary alcoholic functions giving rise to tetraphenyl-tetrahydrofurfurane—



This radicle opens under the action of hydrochloric acid in acetic solution with formation of an unstable chlorated alcohol—



which by loss of HCl and H_2O gives rise to the tetraphenylbutadiene—

$$(C_6H_5)_2C=CH-CH=C(C_6H_5)_2.$$

New Derivatives of Acylcyanacetic Ethers.—Ch. Schmitt.—The author prepares a series of derivatives of acylcyanacetic ethers by the action of acid chlorides on the silver salts of the ethers.

MISCELLANEOUS.

Estimation of Molybdic Acid by Reduction by means of Hydriodic Acid.—F. A. Gooch and O. S. Pulman.—This method consists of reducing molybdic acid to the state of Mo_2O_5 by means of hydriodic acid. Practically we proceed in the following manner:—We treat 0·3 to 0·5 grm. of molybdate with at least 20 c.c. of hydrochloric acid of 1·20 density, and 0·2 to 0·6 grm. of potassic iodide in a vessel of 150 c.c. capacity, covering it with a clock-glass to prevent any loss. Heat to boiling until the original volume of the solution, 40—60 c.c., is reduced to 25 c.c., then dilute to 125 c.c., cool, and transfer to a Drechsel flask fitted laterally with a Will-Varrentrapp tube, which must be filled with a solution of potassic iodide. We then add 0·5 grm. of sulphate of manganese and an excess of titrated solution of permanganate. Finally, we run into the solution a known volume of a solution of arsenious acid. After adding a little tartaric acid, to prevent the precipitation of molybdenum, we neutralise the excess of acid by means of bicarbonate of potassium, and titrate the excess of arsenious acid with a solution of iodine. The amount of permanganate used, lessened by the quantity of arsenious acid added, and increased by the volume of iodine solution used, gives the amount of molybdic acid present in the solution. The results obtained are very accurate.—*Zeit. Anorg. Ch.*, vol. xxix., p. 353.

Yellow Sub-oxide of Copper.—Max Groger.—This sub-oxide is prepared in the following manner:—Ten grms. of pure dry cuprous chloride and 50 grms. of pure sodic chloride are dissolved in 250 c.c. of warm boiled water. We then pour this mixture, drop by drop, by means of a funnel and a tap, stirring vigorously all the while, into a solution in a vessel of 600 c.c. capacity, consisting of 10 grms. of caustic soda, 10 grms. of seignette salt, and 150 c.c. water. The vessel is filled completely with water, stoppered with an indiarubber stopper, and well shaken up with the help of a machine. In this manner we obtain a bright orange-yellow powder, which must be washed with a solution of seignette salt until the filtrate no longer contains a trace of sodic chloride, then with cooled boiled water. The precipitate is dried on a porous plate, then at the ordinary temperature in the air. The precipitate then has a brownish orange-yellow colour. It is not a true hydrated protoxide, but a cuprous oxide retaining a small quantity of water. The author found variable quantities of water from 2·54 to 0·95 per cent. This yellow sub-oxide remains unchanged, when it is dry, in contact with air; when in contact with water oxidation only takes place with difficulty, and probably this is only due to the presence of a trace of alkali. This trace of alkali would have the effect of dissolving a small quantity of the sub-oxide, which, in contact with the air, is transformed into hydrated cupric oxide. The solution of seignette salt reacts on the sub-oxide in contact with the air, giving a blue solution. The crystallised red sub-oxide of copper, obtained by precipitation from Fehling's solution by means of dextrose, is also transformed into the black cupric hydrate on contact with dilute soda solution in the presence of air; but this transformation is much slower than in the case of the yellow sub-oxide. These two modifications are comparable, through their properties, with the two oxides of mercury, the red and the yellow.—*Zeit. Anorg. Ch.*, vol. xxxi., p. 326.

School Board for London.—The Annual Exhibition of Scholars' work from the Board Schools of London will be held at the Examination Hall, Victoria Embankment (adjoining Waterloo Bridge), on Saturday May 9th, 1903, and on the following Monday, Tuesday, and Wednesday (May 11th, 12th, and 13th). The Exhibition will be opened by Lord Reay, G.C.S.I., G.C.I.E. (Chairman of the Board), at 12 o'clock, noon, and will include specimens of Drawings, Colour-work, Modelling, Science Apparatus, Wood-carving, Metal-work, Needlework, Infants' work, Cookery, Laundry-work, and Housewifery from the Day and Evening Schools, and also work from the Schools for the Blind, Deaf, Special Instruction, Truant, and Industrial Schools. Arrangements will also be made for various classes at work in practical Cookery, Laundry-work, &c., during the day-time; and Gymnastics, Dramatic, Literature, &c., in the evenings.

Ethylbenzylaniline.—G. Schultz and E. Bosch.—The authors have made a study of ethylbenzylaniline which was discovered a long while ago, and serves for the preparation of colouring materials, but of which the properties are very little known. This base, which was obtained from the "Farbwerke Höchst." distils at 275—298° at the ordinary pressure, decomposing at 185—186·5° under 22 m.m.; its density is 1·934 at 18·5°. Its picrate fuses at 114°. By nitrating ethylbenzylaniline in cooled sulphuric solution, by means of a mixture of nitric and sulphuric acids also cooled in such a manner that the temperature never exceeds 5°, two nitrated derivatives are obtained, of which one, in orange-yellow prisms, fuses at 69°, and the other, in citron yellow rhombic crystals, at 67°; these two bodies are separated, one from the other, by crystallisation in alcohol. The body fusible at 67°, which only occurs in small quantities, has not yet been examined very closely, but the one fusing at 69° is a mononitroethylbenzylaniline, of which the hydrochlorate fuses at 186° and the picrate at 131°. By oxidation it gives *m*-nitrobenzoïc acid, and by reduction *m*-amido-ethylbenzylaniline, an almost colourless oil distilling at 261—262° under 57 to 58 m.m. pressure. Its hydrochlorate fuses at 188—190°. The nitroso-ethylbenzylaniline was prepared from ethylbenzylaniline by the ordinary method. It crystallises in ether, and fuses at 62°. When boiled with hydrochloric acid we obtain a compound which crystallises in needles and fuses at 216°, and, at the same time, a large quantity of benzaldehyde and an oily base. Nitrosoethylbenzylaniline, when reduced by means of zinc powder, gives *p*-amidoethylbenzylaniline, a thick, nearly colourless oil, which distils without decomposition at 225° under 21 m.m. Its hydrochlorate is very hygroscopic; its oxalate is a white crystalline powder, fusible at 168—169°; its benzoylic derivative occurs in needles, fusible at 124°.—*Berichte*, vol. xxxv, p. 1292.

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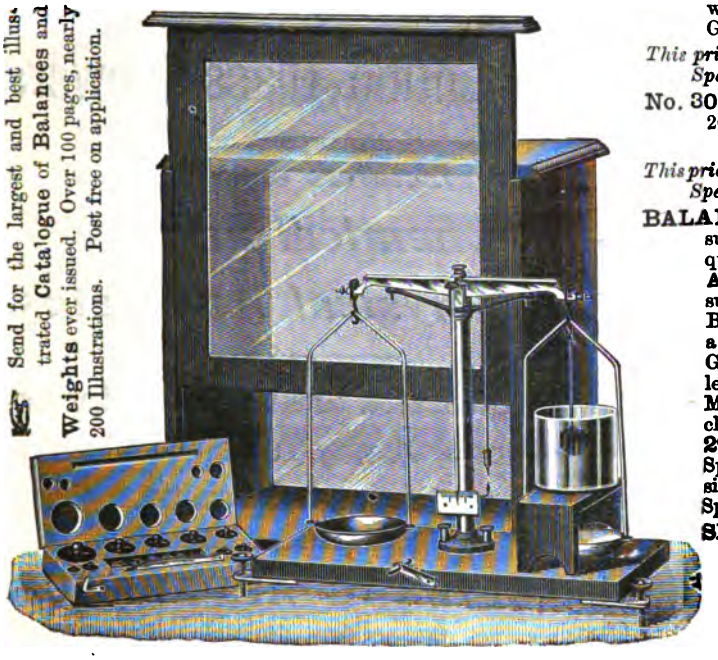

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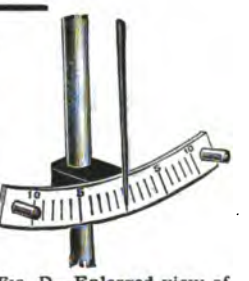

FIG. D.—Enlarged view of Pointer and Scale.

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Height from Hook of Short Pan to Base of Balance, 43 cms.
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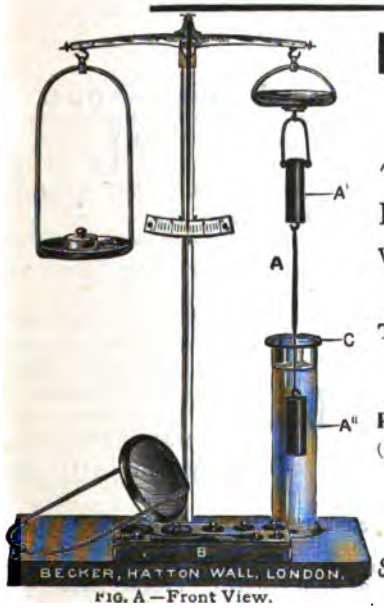

FIG. A.—Front View.

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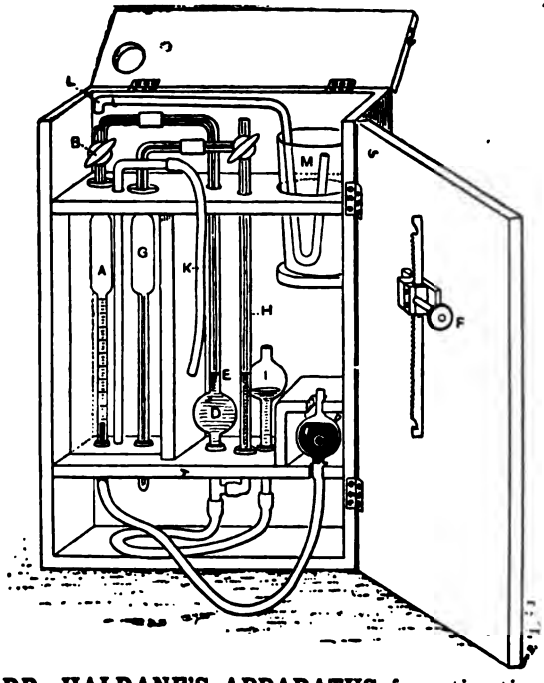

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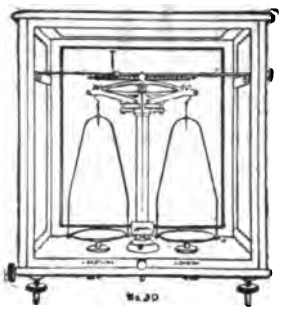

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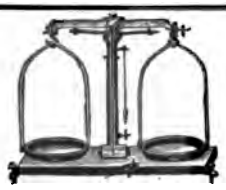

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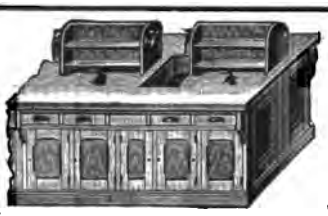

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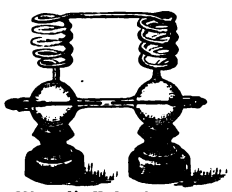

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THE CHEMICAL NEWS.

Vol. LXXXVII., No. 2264.

TENTH ANNUAL REPORT OF THE COMMITTEE ON ATOMIC WEIGHTS. DETERMINATIONS PUBLISHED IN 1902.*

By F. W. CLARKE.

During 1902 there has been a fair amount of activity in the determination of atomic weights, and some of the work published is highly important. One new metal (radium) appears as a definite element for the first time, taking its proper place in the periodic system as a member of the calcium, strontium, barium group. The recorded investigations are summarised below. The work on iodine, calcium, selenium, lanthanum, and uranium is especially worthy of notice.

Iodine.

In order to establish more exactly the relative positions of tellurium and iodine under the periodic law, Ladenburg has re-determined the atomic weight of the latter element (*Ber.*, xxxv., 2275). His process consisted in transforming silver iodide to silver chloride, by heating in chlorine, and a preliminary series of experiments gave the following results. All weights were reduced to a vacuum, and the calculations are based upon O = 16.

Weight AgI.	Weight AgCl.	Atomic weight I.
31·2558	19·0817	126·93
33·7357	20·5930	126·96
49·88229	30·4525	126·94
47·8830	29·2262	126·98
60·1435	36·7154	126·95
41·3649	25·2448	127·01
50·8916	31·0664	126·95
41·3233	25·2200	126·98
80·8139	49·3181	127·02
89·5071	54·6367	126·96
	Mean	126·97

This value is notably higher than that given by Stas, 126·85, and therefore additional determinations were necessary. Three experiments, conducted with the utmost care and with all needful precautions, gave as follows:—

Weight AgI.	Weight AgCl.	Atomic weight I.
62·6608	38·2496	126·957
63·8351	38·9656	126·961
74·7516	45·6288	126·963
	Mean	126·960

This result serves to vindicate the preliminary series, but the cause of the difference from Stas's value is yet to seek. One careful experiment by Stas's method, the synthesis of silver iodide, was made by Ladenburg, whose data, with all corrections applied, are these:—

50·3147 Ag gave 109·4608 AgI. Hence I = 126·87.

Here Stas is corroborated, and the difference is evidently due to the different methods. Ladenburg regards the synthesis of the iodide from silver as attended by much much greater errors than affect the other method, and says that their tendency is to lower the apparent atomic weight of iodine. The new data, therefore, are entitled to very respectful consideration.

Two syntheses of silver iodide are also given by Scott, incidentally to his research upon tellurium (*Proc. Chem. Soc.*, xviii., 112, May 7, 1902). The data are subjoined, and represent reductions to a vacuum, and calculations based upon O = 16 and Ag = 107·93.

Weight Ag.	Weight AgI.	Atomic weight I.
4·6240	10·0634	126·96
6·39978	13·92913	126·98

Here, again, there is a variation from Stas, and an agreement with the higher value obtained by Ladenburg. It seems clear that the atomic weight of iodine should be most carefully scrutinised.

Calcium.

An important preliminary notice by Richards describes a number of experiments upon the atomic weight of calcium (*Journ. Am. Chem. Soc.*, xxiv., 374). The compound studied was the chloride, and the results, reduced to a vacuum, were as follows (O = 16, Cl = 35·455):—

Weight $CaCl_2$.	Weight AgCl.	Atomic weight.
1·56454	4·0409	40·121
3·57630	9·2361	40·130
3·59281	9·2788	40·129
5·00880	12·9364	40·124
9·00246	23·2506	40·125
	Mean	40·126

Still another paper upon this subject, by Hinrichsen (*Zeit. Phys. Chem.*, xl., 746), is supplementary to the memoir which he published in 1901 (*Ibid.*, xxxix., 381). Transparent calcite from Russia was reduced to lime by ignition. After reduction to a vacuum and correction for known impurities in the original material, the subjoined data were obtained.

Weight $CaCO_3$.	Weight CaO.	Atomic weight.
31·20762	17·49526	40·139
22·00588	12·33642	40·136

The value found in 1901 was Ca = 40·142. These figures harmonise with those of Richards, and prove that the formerly accepted number, Ca = 40, is too low.

Selenium.

Atomic weight re-determined by Julius Meyer (*Zeit. Anorg. Chem.*, xxxi., 391; *Ber.*, xxxv., 1591). Silver selenite, scrupulously pure, was analysed electrolytically. The data, with all weights reduced to a vacuum, are as follows:—

Weight Ag_2SeO_3.	Weight Ag.	Per cent Ag.	Atomic weight.
0·5152	0·3241	62·907	79·28
0·5237	0 3295	62·915	79·24
1·8793	1·1826	62·928	79·17
2·1460	1·3503	62·922	79·20
1·6964	1·0672	62·910	79·27
	Mean..		79·23

From the sum of the weights, corrected for a trace of silver which remained in solution after electrolysis, the final result becomes—

Se = 79·21.

This figure is nearly in accord with Lenher's determination, but notably higher than that obtained by Pettersson and Ekman.

Tellurium.

Guthier (*Liebig's Ann. Chem.*, cccxx., 52), in order to determine the atomic weight of tellurium, has studied telluric acid and tellurium dioxide. His analyses depended upon the precipitation of tellurium by hydrazine hydrate, and special precautions were taken to avoid any oxidation of the precipitated metal. The latter was found to be extremely oxidisable. First, two direct determinations were made of water in telluric acid, as follows:—

* *Journal of the American Chemical Society*, xxv., No. 3.

Weight H_2TeO_3.	Weight H_2O.	Per cent H_2O.	Atomic weight.
0·4937	0·1162	23·54	127·60
0·9910	0·2335	23·56	127·70
		Mean	127·65

All weights were reduced to a vacuum, and calculations were based upon O = 16 and H = 1·008.

Secondly, Guthier gives six determinations of tellurium in telluric acid, after several fractional crystallisations of the latter. Three separate fractions were studied, with duplicate determinations on each. The data are given below:—

Weight H_2TeO_3.	Weight Te.	Per cent Te.	Atomic weight.
0·9380	0·5204	55·48	127·20
0·4963	0·2754	55·49	127·25
1·0485	0·5829	55·60	127·80
0·8865	0·4915	55·44	127·00
0·4339	0·2411	55·56	127·60
0·3492	0·1937	55·48	127·34
		Mean	127·365

From tellurium dioxide, similarly reduced, the following data were obtained:—

Weight TeO_2.	Weight Te.	Per cent Te.	Atomic weight.
0·1662	0·13287	79·94	127·50
0·3136	0·2507	79·94	127·50
0·2799	0·2238	79·95	127·60
		Mean..	127·53

The average of the three series of determinations is—

Te = 127·51.

The low results of the second series are probably ascribable to traces of mother-liquor retained in some crystals of the telluric acid.

A preliminary notice upon the atomic weight of tellurium has also been published by Scott (*Proc. Chem. Soc.*, xviii., 112, May 7, 1902). The substances studied were trimethyl tellurium iodide, $Te(CH_3)_3I$, and the corresponding bromide. Analyses of the iodide were as follows:—

Weight $Te(CH_3)_3I$.	Weight AgI.	Atomic weight.
1·7461	1·3688	127·70
6·6425	5·20575	127·66
8·0628	6·3181	127·69

The bromide was titrated with silver solution, and gave these results:—

Weight $Te(CH_3)_3Br$.	Weight Ag.	Atomic weight.
2·4294	1·0373	127·77
6·8424	2·9201	127·78

The second sample of bromide was not so pure as the first. Rejecting it, the mean of the other four determinations gives Te = 127·70. The mean of all five is 127·74. All weights are reduced to a vacuum, and the antecedent values are O = 16, C = 12·00, H = 1·0075, I = 126·85, Br = 79·95, Ag = 107·93.

Lanthanum.

The determinations of atomic weight by Jones were made upon material of remarkable purity (*Am. Chem. Journ.*, xxviii., 23; Chemical News, 1903, lxxxvii., 169). The only contamination which could be detected with the Rowland spectroscope of the Johns Hopkins University, was a trace of cerium amounting to not more than 0·01 per cent, and probably much less. Furthermore, some of the lanthanum oxide was ignited in hydrogen in order to make sure that no oxide higher than La_2O_3 was present. The method of determination was the usual synthesis of sulphate from oxide, and careful experiments showed that under the conditions of the investigation no acid sulphate was formed. The sulphate which was finally weighed was perfectly soluble in water and absolutely neutral in reaction. Twelve determinations are given as follows. The atomic weight was calculated with O = 16 and S = 32·06.

Weight La_2O_3.	Weight $La_2(SO_4)_3$.	Atomic weight.
1·0122	1·7592	138·72
1·1268	1·9581	138 78
0·94585	1·6437	138 77
1·0675	1·8553	138·73
0·9030	1·5692	138·78
1·1273	1·9589	138·79
0·9407	1·6347	138 78
1·0455	1·8168	138·78
1·1271	1·9586	138·78
1·3074	2·2720	138 77
1·3389	2·3267	138·77
1·2012	2·0874	138·78
	Mean	138·77

An attempt was also made to use the oxalate method, but that proved to be unsatisfactory.

A second memoir upon lanthanum, by Brauner and Pavlicek (*Journ. Chem. Soc.*, lxxxi., 1243; also Chemical News, 1903, vol. lxxxvii., p. 49, *et seq.*), is even more elaborate than that of Jones. The method of determination was the same in both cases, but there are many differences of detail. The Bohemian authors find a serious difficulty in the presence of the acid sulphate, for which measured corrections are applied, and they also note another source of error in the hygroscopic character of $La_2(SO_4)_3$. The latter was guarded against by special precautions in weighing. The final results (omitting a preliminary series), with vacuum weights, and all corrections applied, are as follows. The calculations depend upon O = 16 and S = 32·06:—

Weight La_2O_3.	Weight $La_2(SO_4)_3$.	Atomic weight.
1·06562	1·85054	139·036
1·00694	1·74856	139·053
1·12553	1·95457	139·038
1·70276	2·95707	139 026
1·02460	1·77943	139·009
1·28650	2·23419	139·024
1·06488	1·84910	139·068
	Mean	139·036

The reverse method of determination, the ignition of sulphate to oxide, gave bad results. A series of determinations by the oxalate method gave, in mean, La = 139·07, but the individual measurements show a wide range of variation, namely, from 138·67 to 139·66. The value for the atomic weight of lanthanum derived from the sulphate syntheses is doubtless not far from the truth. The mean of the Jones and Brauner values is—

La = 139·905,

and, pending further evidence, this value may properly be adopted; although Brauner, in a later communication (*Zeit. Anorg. Chem.*, xxxiii., 317), criticises the work of Jones and argues in favour of his own determinations. Brauner insists strongly upon the presence of acid sulphate in the lanthanum sulphate studied by Jones, and also suggests that the latter overlooked the hygroscopic nature of his material. If further investigation sustains these criticisms, then the Brauner value is to be preferred.

Ytterbium.

Atomic weight re-determined by Astrid Cleve with very pure material (*Zeit. Anorg. Chem.*, xxii., 129; Chemical News, lxxxvi., 248). The method employed was the synthesis of the sulphate from the oxide. The data are as follows, when O = 16 and S = 32·06:—

Weight Yb_2O_3.	Weight $Yb_2(SO_4)_3$.	Atomic weight.
0·7791	1·2535	173·22
0·5190	0·8353	173 05
0·4995	0·7894	173 07

These figures confirm the earlier determination by Nilson.

Uranium.

The work of Richards and Merigold upon the atomic weight of uranium is rich in details, and also in matter relative to probable sources of error (*Proc. Amer. Acad.*, xxxvii., 365; Chemical News, lxxxv., 177, *et seq.*). The substance finally chosen for study was uranous bromide prepared by sublimation, and scrupulously protected from the oxidising action of the air. It contained a minute quantity of sodium bromide, but the amount of this was determined and the necessary correction was applied. All weights refer to a vacuum, and the antecedent atomic weights were O = 16, Ag = 107·93, and Br = 79·955. A preliminary series of analyses gave as follows, all corrections included.

Weight UBr_4.	Weight AgBr.	Atomic weight.
2·2058	2·9699	238·36
1·4418	1·9401	238·69
1·4050	1·8910	238·56
1·1749	1·5818	238·39
	Mean	238·50

In another and final set of experiments, the uranous bromide was titrated with known amounts of pure silver, and the precipitated silver bromide was also weighed. Hence two ratios were determined with the following results:—

Weight UBr_4.	Weight AgBr.	Atomic weight.
1·7999	2·4226	238·54
1·0662	1·4352	238·50
1·8551	2·4967	238·59
Mean		238·54

Weight UBr_4.	Weight Ag.	Atomic weight.
1·7999	1·3918	238·49
1·0662	0·8245	238·46
1·8551	1·4342	238·60
Mean		238·52
Average of all determinations.. ..		238·52
Average of last six determinations..		238·53

This result is notably lower than the usually accepted value for the atomic weight of uranium.

From Series 2 and 3 the ratio between silver and bromine may be deduced. It gives for the percentage of Ag in AgBr the number 57·447. Stas found 57·445. This agreement is eminently satisfactory.

Radium.

By many fractional crystallisations, Madame Curie (*Comptes Rendus*, cxxxv., 161; Chem. News, lxxxvi., 61) has succeeded in preparing radium chloride sufficiently pure for determinations of the atomic weight of the metal. According to Demarçay, who examined the spectrum of the material, it contained a minimum quantity of barium, incapable of exerting any appreciable influence upon the atomic weight. Three analyses were made, the chlorine being weighed as silver chloride, with the following values deduced for the atomic weight of radium.

	225·3
	225·8
	224·0
Mean..	225·0

Miscellaneous Notes.

Several papers have appeared during the year dealing with numerical relations between the atomic weights of the various elements. Three of them, by Bilecki (*Chem. Zeit.*, xxvi., 399). Marshall (*Chem. Zeit.*, xxvi., 663; Chem. News, lxxxvi., 88), and Hollins (Chem. News, lxxxvi., 147), relate to possible modifications of "Prout's law"; that is, they point out relations analogous to, but not identical with, those assumed by Prout. Schmidt (*Zeit. Anorg. Chem.*, xxxi., 147) and Stoney (*Phil. Mag.*, [6], iv., 411 and 504) discuss the connection of the atomic weights in a more purely mathematical way, and so, too, does Vincent (*Phil. Mag.*, [6], iv., 103). The logarithmic spiral of Stoney is especially suggestive. There is also an elaborate memoir by Lord Kelvin (*Phil. Mag.*, [6], iv., 177 and 281) on the "weights of atoms; and a discussion by Clarke (*Am. Chem. Journ.*, xxvii., 321; Chem. News, lxxxvi., 77) of the best method for the reduction and combination of atomic weight determinations. Ebaugh's work on the atomic weight of arsenic, which was cited in the report of your committee for 1901, has appeared in full in the *Journal of the American Chemical Society*, xxiv., 489, June, 1902.

International Committee on Atomic Weights.

This committee, which was too large for effective working, has appointed a smaller body for action. This smaller committee, consisting of F. W. Clarke, T. E. Thorpe, and Karl Seubert, has already reported, and its report has appeared in the *Journal of the American Chemical Society*, xxv., p. 1, January, 1903; *Zeit. Angew. Chemie*, xv., 1305; and the Chemical News, 1903, lxxxvii., p. 79). The table of atomic weights, there given, need not be repeated here.

A RE-DETERMINATION OF THE ATOMIC WEIGHT OF LANTHANUM.*

By HARRY C. JONES.

(Concluded from p. 171).

The Results.

Twelve determinations were completed by the method just described, and the results are given below, calculated on the basis of oxygen = 16, sulphur = 32·06. These include every determination which was completed. A few determinations were lost by accident, especially in the earlier stages of the work, due to the spattering of the sulphate upon the lid of the crucible. These determinations were interrupted as soon as any spattering was discovered, and the resulting sulphate was not weighed.

	La_2O_3.	$La_2(SO_4)_3$.	$3SO_3 = 240·18$.	At. wt. La.
I.	1·0122	1·7592	0·7470	138·72
II.	1·1268	1·9581	0·8313	138·72
III.	0·94585	1·6437	0 69785	138 77
IV.	1·0575	1·8553	0·7878	138·73
V.	0·9030	1·5692	0·6662	138·78
VI.	1·1273	1·9589	0·8316	138·79
VII.	0·9407	1·6347	0·6940	138·78
VIII.	1·0455	1 8168	0·7713	138·78
IX.	1·1271	1·9586	0·8315	138·78
X.	1·3074	2·2720	0·9646	138·77
XI.	1·3389	2·3267	0·9878	138·77
XII.	1 2012	2·0874	0·8862	138·78

Taking the mean of the twelve determinations, we have for the atomic weight of lanthanum the value 138·77.

Attempt to Use the Oxalate Method.

An attempt was made to determine the atomic weight of lanthanum by decomposing the oxalate of lanthanum to the oxide, or by determining the oxalic acid in the oxalate by titration with a standard solution of potassium permanganate. This method had to be abandoned on account of the nature of lanthanum oxalate. It was found to be practically impossible to obtain lanthanum oxalate under conditions where it would give constant weight. The oxalate continued to lose in weight when dried for several days at 110°; it further lost in weight when dried at 150°, and still further loss in weight was sustained when it was heated to 190°. A specimen which had been dried

* From the *American Chemical Journal*, xxviii., No. 1.

for a week at 190° gave off a very considerable quantity of water when heated from 230° to 240°, showing that considerable water had been retained by the oxalate above 200°.

The decomposition temperature of lanthanum oxalate was then studied. The salt was placed in a glass tube closed at one end and connected at the other with a wash-bottle closed by means of a ground-glass stopper. A solution of barium hydroxide was introduced into the bottle and protected from the carbon dioxide in the air by connecting it with a second similar bottle containing a solution of sodium hydroxide. Any carbon dioxide escaping from the decomposing oxalate was thus conducted through the solution of barium hydroxide. The oxalate was found to show incipient decomposition at 250°, which became very marked at somewhat higher temperatures.

Since the oxalate continued to give off water so close to its decomposition temperature, it was not safe to completely dehydrate the salt and weigh it for the purpose of an atomic weight determination. The oxalate method for determining the atomic weight of lanthanum was, therefore, abandoned.

The result of the above investigation is, then, to show that the atomic weight of lanthanum is 138·77 on the basis of oxygen = 16.

THE MYSTERY OF RADIUM.

By Sir WILLIAM CROOKES, F.R.S.

The following letter appeared in *The Times* of April 7th:—

Sir,—Allow me to reply to your correspondents "Ignoramus" and "Physicus." I will do so as briefly as possible.

I did not nearly fill a line with ciphers to order to impress your readers. I had to do so for accuracy's sake. In England we form billions, trillions, &c., by multiplying the previous denomination by a million; in France and the United States this is effected by multiplying by a thousand. Therefore without the array of ciphers my notation would not have been understood.

"Ignoramus" says that the physical effect is mathematically proportionate to the number of molecules in the bulb; and he asks on what grounds do I assume that one unit of gas occupying a given space can produce a physical effect equal to that produced by a million units occupying the same space? My answer is that the physical effects in the rare gas will be incomparably greater than in the dense gas. Ratio has nothing to do with the matter. It is true, as your correspondents say, that air at an exhaustion of a millionth of an atmosphere is a million times less dense; but they forget that the mobility of the molecules is enormously increased; their mean free path, instead of being the ten-thousandth of a millimetre as at ordinary pressures, being lengthened to about a hundred millimetres.

Crowding does not depend so much on the number of bodies present in a given space as on the size of each body. An audience of a thousand would crowd inconveniently the theatre of the Royal Institution, but a thousand bees could fly about in the same space with no inconvenience. In the former case collisions would be almost continuous, whilst with the smaller bodies their mean free paths would be so long that the hits in a given time might be disregarded in proportion to the misses. And the same reasoning applies if we reduce the number of units present instead of diminishing their size. In spite of the fact that in air there are a trillion molecules still present at an exhaustion of a millionth, the hits in a given time are sufficiently few that we no longer have to deal with almost continuous matter, but we can contemplate, as it were, molecular actions individually. The properties which constitute gaseity are here reduced to a *minimum*, and the average molecule is free to obey its own laws with but little interference. Hence the phenomena, thermal, electrical, and mechanical, observed in "high vacua," in spite of the trillions present.

I am your obedient servant,

WILLIAM CROOKES.

London, April 4.

THE EFFECT OF CERTAIN POISONS ON INORGANIC FERMENTS.*

By HARRY C. JONES, Ph.D.,
Associate Professor of Physical Chemistry in the Johns Hopkins University.

A brief review of the work of Bredig and his pupils on inorganic ferments has already appeared in the *Johns Hopkins Hospital Bulletin*, No. 114, Septemper, 1900, p. 224. This work has been continued, and some striking relations between the inorganic ferments and certain enzymes have been established.

The inorganic ferments in question are finely divided metals, such as platinum, gold, silver, cadmium, &c. The metals are obtained in the finely divided condition by dipping bars of the metal into pure water, and passing a heavy electric current from one bar to the other through the water. The metal under these conditions is torn off in a state of such fine division that it remains suspended in the water in the form of a solution. Indeed, the metal is in such a state of division that the most powerful microscope fails to reveal any heterogeneity when a drop of the solution is brought beneath it. From this it might be concluded that these solutions of the metals are true solutions. Such, however, is not the case. True solutions freeze lower than the pure solvent, have less vapour-tension or boil higher than the pure solvent, and exert osmotic pressure. The solutions in question of the metals have none of these properties. They have the same freezing-point, the same vapour-tension or boiling-point as the pure solvent, and do not exert any osmotic pressure. To distinguish these solutions of the metals from true solutions they have been termed *pseudo-solutions* or *colloidal solutions*.

These are in no sense a new class of solutions. Examples of colloidal solutions have long been known. Solutions of starch, albumen, and the like are as truly colloidal solutions as those of the metals. The solutions of the metals, however, have certain remarkable properties which seem to resemble in many respects the properties of the organic ferments. Some of these were referred to in the earlier review. It was noted that a colloidal solution of platinum accelerates the oxidation of alcohol to acetic acid in the presence of the oxygen of the air, as well as the organic ferment *mycoderma aceti*.

Finely divided iridium decomposes calcium formate into calcium carbonate, carbon dioxide, and hydrogen in the same manner as certain bacteria.

The analogy between the action of the finely divided metals and ferments was not limited to fermentation proper, oxidation, &c.; but held also for diastatic phenomena such as the inversion of cane-sugar. The finely divided metals effected the inversion of cane-sugar in a manner which was strictly analogous to the action of invertase.

Again, hydrogen dioxide was decomposed into water and oxygen in exactly the same manner by the colloidal solutions of the metals as by the ferments in the blood.

Many relations similar to the above were pointed out by Bredig and von Berneck, in the first communication on this subject (*Zeit. Phys. Chem.*, 1899. xxxi., 258). These relations are, however, purely qualitative, and alone are entirely insufficient to establish any deep-seated connection

* From *The Johns Hopkins Hospital Bulletin*, vol. xiii., No. 134.

between the action of the finely divided metals on the one hand and organic ferments on the other.

The first investigation was a quantitative study of the action of the colloidal solutions of the metals as compared with the action of organic ferments. As this has already been reviewed, a brief reference to the conclusions reached by Bredig and von Berneck is sufficient.

It was shown in the first place that very small amounts of metal can effect the decomposition of enormous quantities of hydrogen dioxide, just as very small amounts of organic ferments can effect relatively large transformations. This analogy is, however, not necessarily very striking.

It was then shown that the finely divided metals do not enter into the reaction which they effect. The method by which this was proved was considered at sufficient length in the earlier review (*Johns Hopkins Hospital Bulletin*, 1900, 114, 225).

Substances which behave in this manner, *i.e.*, act by means of their surface alone without entering into the reaction, are known as *Catalysers*, and such reactions are termed *catalytic*. The collodial solutions of the metals, then, act catalytically. It is also well known that enzymes act catalytically. They do not enter into the reaction as such, but act simply by contact through their surface.

This analogy between the action of the colloidal metals and the enzymes is much closer than that first referred to, and makes it probable that the relations between the two are really deep seated. There is, however, a relation far more striking than either of those considered above.

It is well known that the enzymes are very sensitive to certain substances, which, in infinitesimal quantities, may retard or entirely prevent their action. Thus, hydrocyanic acid, carbon bisulphide, hydrogen sulphide, and the like, when present in mere traces, may interfere seriously with the action of certain ferments. It has been shown that the merest trace of substances like the above may seriously interfere with the action of the colloidal solutions of the metals—may *poison* the finely divided metals. It is with this subject that the present review has to deal directly.

In their first paper certain qualitative observations were made by Bredig and von Berneck on the poisonous action of a few substances on colloidal solutions of platinum. This subject has subsequently been studied quantitatively by Bredig and Ikeda (*Zeit. Phys. Chem.*, 1901, xxxvii., 1). They have worked with colloidal solutions of platinum, and have studied the rate at which these decompose hydrogen dioxide. Solutions of certain poisons of different concentrations were added to the colloidal solution of platinum, and the rate determined at which the colloidal solution, after it had been poisoned, decomposed hydrogen dioxide.

The velocity of the decomposition was found to diminish when the poison had been added to the colloidal solution, and the amount of diminution depended upon the amount of poison present. The diminution in the velocity was worked out numerically, but the results can be seen most readily by means of curves.

Fig. 1 represents the results obtained with hydrocyanic acid as the poison. The abscissa represents the time during which the reaction has proceeded. The ordinate, log $\frac{T_o}{T}$, is really log $\frac{A}{A-x}$, in which A is the amount of the hydrogen dioxide originally present and x the amount decomposed. Without going more fully into this expression it may be stated that it is obtained by integrating the equation for a first order reaction derived from the law of mass action.

The concentration of the colloidal solution of platinum which was used, C_{Pt}, contained 0·0000103 of a grm.-atomic weight per litre. The concentration of the hydrocyanic acid which was employed, C_{CNH}, expresses the number of grm.-molecules of the acid in a litre of the solution.

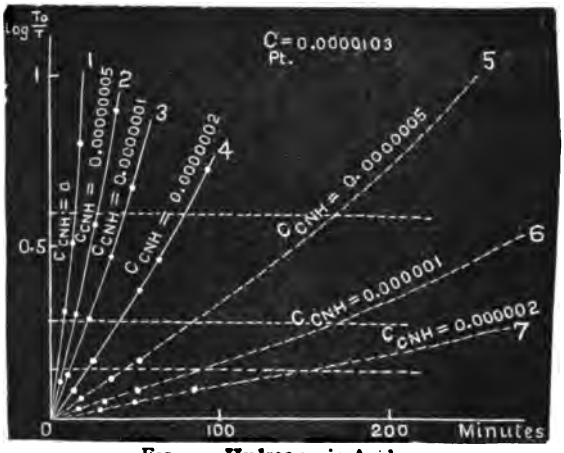


FIG. 1.—Hydrocyanic Acid.

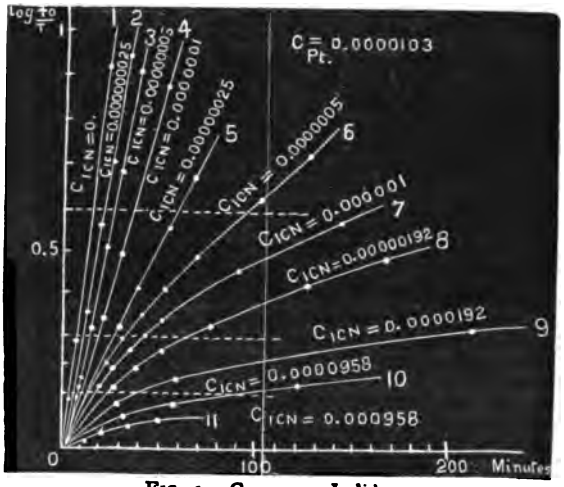


FIG. 2.—Cyanogen Iodide.

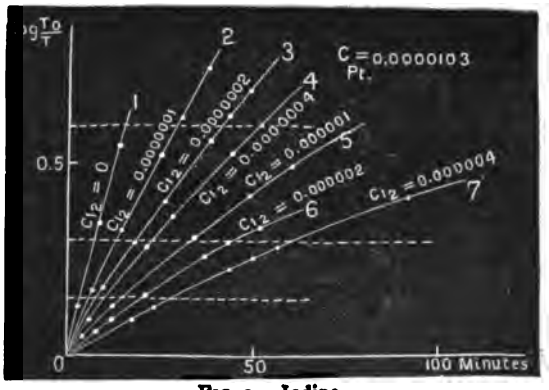


FIG. 3.—Iodine.

Curve 1 represents the reaction when no poison is present. Curves 2 to 7 represent the reactions when increasing amounts of the poison were present. Take curve 5. Here the reaction velocity has been reduced to about one-half, and this has been effected by a solution of hydrocyanic acid containing *one grm.-molecular weight in two million litres.* Such a solution contains in a litre

only 0·014 m.grm. of hydrocyanic acid, and yet is capable of diminishing the action of the colloidal platinum to one-half.

Curves 4, 3, and 2 represent decreasing amounts of the poison as expressed by the values of C. Curve 2 represents the effect of a solution of hydrocyanic acid so dilute that it contains *one grm.-molecular weight in twenty million litres* of the solution; and at such inconceivable dilutions the action of the platinum is considerably lessened.

It has been found that the action of the enzymes in the blood in decomposing hydrogen dioxide is very appreciably lessened by the addition of a solution of hydrocyanic acid containing 0·002 m.grm. in a litre.

A careful examination of the curves brings out another very interesting relation. The curves for the most dilute solutions of hydrocyanic acid are convex to the abscissa from the very origin. This means that the poison is having less and less effect as the time increases—the colloidal solution of the platinum is *recovering from the poison.*

Where the solution of the hydrocyanic acid is stronger (curves 5, 6, and 7) the curve is at first concave to the abscissa, and becomes convex only after a much longer time has elapsed. While the curve is concave to the abscissa the action of the poison is increasing, and the platinum begins to recover from the effect of the poison only after a much longer interval of time.

Similarly, it has been shown that the enzymes in the blood and ferments can recover from the poisonous action of minute traces of hydrocyanic acid.

It is pointed out that both of these effects are probably due to the oxidation of the hydrocyanic acid in the solution.

A more violent poison than hydrocyanic acid is cyanogen iodide. The results obtained with this substance are shown in Fig. 2.

Curve 1 represents the reaction when none of the poison is present. Curves 2 to 11 represent the results with increasing amounts of the poison. When the concentration of the poison is such that a *grm.-molecular weight is contained in forty million litres* of the solution, the action of the platinum is very appreciably diminished. The diminution in the velocity of the reaction is increased as the concentration of the poison becomes greater and greater. When the poison has acquired a concentration of a grm.-molecular weight in about thirteen million litres, the velocity of the reaction is reduced to one-half.

These curves show that the colloidal solution of platinum can *recover* also from the poisonous action of cyanogen iodide, provided the poison is not too concentrated. If the dilution is greater than a grm.-molecular weight in a million litres (curves 2 to 6) the platinum can recover in part from the effect of the poison, as is shown by the curves becoming convex to the abscissa. If the concentration is greater than one million litres the curves remain concave to the abscissa, which means that the colloidal solution cannot recover from the effect of the poison.

It should be noted that cyanogen iodide is one of the strongest poisons toward blood and protoplasm in general.

The effect of one other poison will be taken up, since it represents the case where the colloidal solution cannot recover at all from the poisonous effects. This poison is *iodine.* The results obtained are shown in Fig. 3. From what has already been said concerning the curves in Figs. 1 and 2, the curves in Fig. 3 are self-explanatory. It will be observed that none of the curves become convex to the abscissa, which means that no matter how dilute the poison, provided that it is sufficiently concentrated to have any appreciable effect, the platinum cannot recover from its influence.

The curves show also that iodine is a powerful poison on the colloidal metal, and it is known to be an intense blood poison.

In a manner exactly analogous to that described above, Bredig and Ikeda have studied the poisonous action of about thirty substances on colloidal solutions of platinum. The strongest poisons in addition to those described above are mercuric chloride, hydrogen sulphide, sodium thiosulphate, carbon monoxide, phosphorus, phosphine, arsine, mercuric cyanide, and carbon bisulphide. From the effect of some of these substances the platinum was able to recover, as in the cases of hydrocyanic acid and cyanogen iodide, while the action of others remained permanent as with iodine. Among the substances which are less poisonous to the platinum are aniline, hydroxylamine, bromine, hydrochloric acid, oxalic acid, amyl nitrite, arsenious acid, sodium sulphite, and ammonium chloride.

The weak poisons are;—Phosphorous acid, sodium nitrite, nitrous acid, pyrogallol, nitrobenzene, ammonium fluoride, &c.

A few substances were found to be nearly neutral in their action, such as potassium chlorate, ethyl alcohol, amyl alcohol, ether, glycerol, oil of turpentine, and chloroform; while formic acid, hydrazine, and dilute nitric acid increased the activity of the colloidal platinum in breaking down hydrogen dioxide.

At the close of their paper Bredig and Ikeda compared the action of a number of substances on the power of colloidal platinum on the one hand, and of blood on the other, to break down hydrogen dioxide. Their results are given in the following table:—

Retardation of the Catalytic Decomposition of H_2O_2.

	By Blood. Catalysis—	By Colloida Platinum. Catalysis—
Hydrogen Sulphide	No catalysis.	Very strongly retarded.
Iodine	Very strongly retarded.	Very strongly retarded.
Mercuric Chloride .	Almost entirely prevented.	Very strongly retarded.
Mercuric Cyanide .	Very considerably weakened.	Very strongly retarded.
Hydrocyanic Acid .	Very considerably weakened.	Very strongly retarded.
Hydroxylamine ..	Entirely prevented.	Strongly retarded.
Amyl Nitrate ..	Strongly retarded.	Strongly retarded.
Nitrobenzene ..	Appreciably weakened.	Slightly weakened.
Pyrogallol	Not lessened.	Slightly lessened.
Arsenious Acid ..	Inappreciably lessened.	Slightly lessened.
Potassium Chlorate	Slightly decreased.	Not decreased.
Aniline	Strongly increased.	Considerably decreased.

That there is a general agreement between the action of poisons on organic and inorganic ferments is unmistakable from the above results. Certain differences, however, manifest themselves as in the case of aniline, and it is impossible to say at present what these mean.

An impartial examination, however, of all the evidence bearing upon the relation between organic and inorganic ferments will certainly lead to the conclusion that these analogies are not accidental. The state of mind of Bredig on this whole problem can be seen best by quoting the following paragraphs from his monograph on this subject:—

"All these facts point to an unmistakable analogy between the contact actions in the inorganic world and the actions of ferments in the organic world. As in the case of my colloidal catalysers, we are dealing with reactions in which enormously developed surfaces are involved, so is it probable that the same condition obtains in the actions of ferments, enzymes, blood corpuscles, and oxidising and catalysing organic substances. We see,

therefore, that the organism develops its enormous surfaces in the tissues and colloidal ferments not only because it requires osmotic processes, but on account of the very great catalytic activity of such surfaces. If, as Boltzmann says, the war for existence which living matter must wage is a war about free energy, certainly, of all the forms of free energy the *free energy of surface* is the most important for the organism.

"In conclusion, I need scarcely state that I do not maintain that there is any mysterious identity between the metals and the enzymes. But without exaggerating the overwhelmingly large number of analogies, we are compelled to regard the colloidal solutions of the metals, in many relations at least, *as inorganic models of the organic enzymes*."

The author would refer the action of the colloidal solutions of the metals, the enzymes, and catalysis generally to the *surface energy* possessed by these substances. We are thus led one step nearer to the solution of the nature of catalysis, which underlies so many of the processes of living as well as dead matter.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

ANNUAL GENERAL MEETING, *March 25th*, 1903.

Prof. J. EMERSON REYNOLDS, Sc.D., F.R.S., President, in the Chair.

DR. L. T. THORNE and Dr. K. J. P. ORTON were appointed scrutators, and the ballot was opened for the election of Officers and Council for the ensuing year. The PRESIDENT then presented the following Report on the state of the Society during the past twelve months:—

Report of the Council.

The Council have the satisfaction of announcing that the numerical strength of the Society, which, on March 26th, 1902, was 2416 is now 2471, the highest number yet reached. Since the last Annual General Meeting, 130 Fellows have been elected and 6 have been reinstated by the Council, making a gross total of 2552. Of these, 27 have been removed for non-payment of two subscriptions, 33 have withdrawn, and 21 have died, making 55 the net increase in the number of Fellows.

By the death of Professor J. Wislicenus, F.R.S., the number of Foreign Fellows has been reduced to 31.

The following Fellows have died:—Sir F. A. Abel, Bart., F.R.S.; Dr. C. M. Aikman; F. B. Benger; C. R. Blackett; Prof. G. Bischoff; Dr. E. Demarçay; W. C. Forsyth; T. E. Gee; Dr. J. H. Gladstone, F.R.S.; G. Griffith; Prof. J. J. Hummel; R. Jackson; W. I. Macadam; J. Moss; J. Robbins; Sir W. C. Roberts-Austen, K.C.B., F.R.S.; Dr. E. Schunck, F.R.S.; J. Sim; W. H. Stanger; E. Truman; M. Zingler.

The scientific work of the Society during the past session abundantly testifies to its continued activity. Since the last Annual General Meeting, 189 scientific communications have been made to the Society, 118 of which have already been published in the *Transactions*, and abstracts of all have appeared in the *Proceedings*.

The *Transactions* for 1902 contains 160 memoirs, occupying 1604 pages, whilst the volume for the preceding year contains 146 memoirs which occupy 1411 pages. In addition, the volume for 1902 contains the Raoult Memorial Lecture.

The *Journal* for 1902 contains also 3854 abstracts of papers, published mainly in foreign journals, which extend to 1564 pages. These abstracts may be classified as follows:—

PART I.	Pages.	No. of Abstracts.
Organic Chemistry	852	1632
PART II.		
General and Physical Chemistry		409
Inorganic Chemistry		428
Mineralogical Chemistry		154
Physiological Chemistry		421
Chemistry of Vegetable Physiology and Agriculture		281
Analytical Chemistry		529
	712	2222
Total in Parts I. and II. ..	1564	3854

The Council desires to offer the congratulations of the Society to Professor G. D. Liveing, F.R.S., and to Mr. J. G. Hepburn, who this year reach the Fiftieth Anniversary of their election as Fellows.

The Society has to lament the death of one distinguished Foreign Fellow, Professor J. Wislicenus, F.R.S., and of twenty-one Fellows, amongst whom are two Past Presidents, Sir F. A. Abel, Bart., F.R.S., and Dr. J. H. Gladstone, F.R.S., who had been Fellows for the long period of fifty-five years; other notable names are those of Sir W. C. Roberts-Austen, K.C.B., F.R.S., Professor J. J. Hummel, and Dr. E. Schunck, F.R.S. Obituary notices of these will appear in the Journal.

The Raoult Memorial Lecture was delivered before a large audience in the Theatre of the Royal Institution (the use of which was kindly granted for the occasion by the Managers) on March 26th, 1902, by Prof. J. H. van't Hoff, F.R.S.

The Council are glad to be able to announce that Prof. W. H. Perkin, F.R.S., has undertaken to deliver the Wislicenus Memorial Lecture towards the end of the present year.

The Society, in conjunction with the Royal Society and the other Scientific Societies having rooms in Burlington House, arranged for the decoration and illumination of the Building on the occasion of the Coronation of the King.

The plan of holding the Ordinary Meetings of the Society alternately on Wednesdays, at 5.30 p.m., and on Thursdays, at 8 p.m., which was tried for the first time last session, proved so satisfactory that the Council determined to continue the practice during the present session. Both sets of meetings have been equally well attended, and the meetings held on Wednesdays appear, in particular, to suit the convenience of Fellows resident at distance from London.

The Joint International Committee on Atomic Weights, on which the Society is represented by Prof. Thorpe, has issued its first Report. This report, which includes a new table of atomic weights, has been printed in full, both in the *Journal* and the *Proceedings*.

The Society having been invited by the Organising Commitee of the Fifth International Congress of Applied Chemistry to co-operate with other societies in this country in securing a proper representation of English chemistry, the Council, in June last, appointed a committee to take action in the matter, and have nominated, as its Delegates to represent the Society at the meeting of the Congress in Berlin in June next, the following Fellows:—Prof. W. A. Tilden, Prof. W. R. Dunstan, Prof. W. H. Perkin, and Dr. A. Scott.

A petition has been addressed to the Council requesting them to consider the desirability of limiting the period of service of the Honorary Secretaries and of the Foreign Secretary. The Council having fully considered the matter, passed, *nem. con.*, a resolution stating that whilst the tenure of office should not be indefinitely extended, it was not expedient to fix a definite term of years to the tenure of these offices.

The rapid growth of the Library rendered it imperative

that additional accommodation for its extension should be obtained at once. This has been accomplished by utilising for that purpose some of the rooms of the basement, and plans are at present under consideration by which storage accommodation there for the less used books may allow of the normal growth of the Library for another ten or twelve years without its being unduly cramped. This, along with the constantly increasing amount of work entailed by the continuous growth and prosperity of the Society, rendered necessary the re-arrangement of the duties of the Staff. After careful consideration, the Council decided to separate the duties of Assistant Secretary from those of the Librarian and Curator, Mr. Steele retaining the latter, whilst Mr. S. E. Carr has been appointed Assistant Secretary.

A complete card catalogue of the Library has now been made, and the new Catalogue, arranged both according to authors and subjects, was issued at the beginning of the present year at the price of half-a-crown. The Library continues to be increasingly used by the Fellows. 925 books were borrowed during the year as against 873 in the previous year. The additions to the Library comprised 64 books, 338 volumes of periodicals, and 23 pamphlets, the corresponding numbers of which in the year before were 153, 441, and 33 respectively. Of the books, 48 have been presented to the Society.

Grants amounting in all to £230 have been made from the Research Fund.

The Council here desires to place on record its high appreciation of the conspicuous services of Prof. Dunstan, who now retires from the post of Honorary Secretary which he has held with such advantage to the Society, and who, for the last ten years, has given unsparingly both his time and his energy to the promotion of its highest interests. As one of the Vice-Presidents, the Council hope to have him among them for some time to come.

Another material change in the administrative officers of the Society comes into force with the nomination of the Treasurer, Prof. Tilden, to the highest office in the Society, that of President. The Council acknowledges with gratitude the skill and foresight with which, for the last four years, he has controlled the finances of the Society, and it is largely owing to his management, as well as to the ever increasing prosperity of the Society, that the Council has been able to introduce several important reforms and re-arrangements. These are alluded to elsewhere in this report, and it is hoped that they will greatly increase the usefulness of the Society.

Prof. W. P. Wynne found it necessary, to the great regret of the Council, to resign the post of Editor of the *Journal* which he has held for the last four years with such credit to the Society, but kindly consented to act as Editor until the end of 1902, when he was succeeded by Dr. G. T. Morgan, who, in addition to editing the *Journal*, now edits the *Proceedings* of the Society.

Report of the Treasurer.

The Treasurer, in presenting the balance sheet for the year, stated that the net income was £6212 5s. 1d., whilst the expenses had been £5384 18s., leaving a surplus of £827 7s. 1d., which was about one hundred pounds less than the surplus income in 1902. This was due to several causes, namely, the increase of nearly £380 in the cost of the *Journal* and *Proceedings*, the additions to the item of salaries and wages, and the expenses on account of the Collective Index. Whilst, therefore, the present surplus is satisfactory in that it exceeds the amount paid into the account in the form of compositions and admission fees, all these three forms of expenditure will still require careful watching. Three years ago, at the end of his first year as Treasurer, he made an appeal to authors of papers with reference to the preparation of copy for the printers, and he could not help thinking that in the near future more stringent regulations in regard both to the state of the manuscript and the dimensions of papers would have to be imposed with the object of keeping the cost of printing within the means at the disposal of the Society. The Abstracts of foreign and other journals are now indispensable, but, notwithstanding the care exercised by the Sub-Editor, to whom the Society is greatly indebted, and the very moderate remuneration of the excellent body of Abstractors, the cost of their preparation is very heavy.

The amount which will appear in the next balance sheet under the heads of salaries and wages will be somewhat larger, inasmuch as the increase will represent that for an entire year instead of only half a year as on the present occasion. The total cost of the last two volumes of the General Index was £1740, whilst the expenditure on the volume which is in course of preparation has, up to the present, been £204. The greater part of the cost is therefore still to be met. On the other hand, the Library Catalogue is now completed, and for some years there need be no further expense in that form, although additional accommodation for the books will have to be provided immediately at an outlay which will probably approach £200.

The following tabular statement contains the chief items of income and expenditure during the past four years. The figures represent pounds, the shillings and pence being omitted. It will be seen that whilst the income of the Society is increasing the expenses are growing at nearly the same rate.

	1900.	1901.	1902.	1903.
Compositions . ..	110	282	168	299
Admission Fees ..	468	464	652	520
Subscriptions . ..	3510	3544	3712	3957
Sale of Journals ..	781	880	835	888
Dividends	444	464	476	506
Net Income	5371	5668	5844	6212
Assets	16710	17156	17807	18446
Expenses	4993	4932	4913	5384
Surplus	377	736	930	827

The Treasurer recalled with satisfaction the sale of Consols previously held by the Society in his first year of office. A serious loss was thus avoided, and, by the re-investment of the proceeds, a slight addition was secured to the income of the Society.

The estimated values of the securities are all slightly less than at this time last year, but the further investment in May last in £1200 of Leeds Corporation Stock now brings the Assets of the Society to the respectable figure of £18,446 17s. 3d.

The Treasurer, in concluding, proposed a vote of thanks to the auditors, which was acknowledged by Dr. L. T. Thorne.

Prof. Dewar proposed a vote of thanks to the Treasurer, Secretaries, and Council. The motion was seconded by Prof. W. H. Perkin, and unanimously adopted. Prof. Dunstan responded.

The President, then delivered his Address, in which he called attention to the publication of some recent reports on progress in chemical research, and urged the publication of similar digests. He mentioned that this year would see the centenary of Dalton's statement of his atomic theory, which rose, as Nernst truly said, "by a single effort of modern science, like a phœnix from the ashes of the old Greek philosophy." He urged the study of "comparative chemistry" of inorganic compounds. There were few inquiries of greater interest than those involving inorganic isomerism, which was now either completely ignored or only slightly mentioned. Polymerism, or molecular condensation, was well known to exist in many inorganic compounds, as in the oxides of nitrogen, vanadium, niobium, and tantalum. Silicon showed a great analogy to carbon, and it was highly probable that some of the native silicates were benzenoid combinations of $6SiO_2$. The more familiar cases of isomerism were the nitrites and sulphites, and isomerism had also been ob-

served in the thiosulphates and the salts of the phosphorous acids. Attention was directed to some cobalt, platinum, and molybdenum compounds which showed this peculiarity. Another analogy between carbon and inorganic compounds was the curious and interesting catalytic action, referred to by Bredig under the title of "inorganic ferments." Colloid platinum solutions acted on many substances in the same way and under similar laws as enzymes. The whole subject was little known, but it suggested that the broader study of inorganic chemistry, especially in the light of our knowledge of the "organic" division of the science, was well worthy of much greater attention than it had received of late.

Dr. Russell, in moving the adoption of the Report, proposed a vote of thanks to the President, coupled with a request that he would allow his Address to be printed in the *Transactions*.

Prof. Thorpe seconded the motion, which was carried by acclamation.

After the President had returned thanks, the scrutators presented their report to the President, when he declared the following to have been duly elected as Officers and Council for the ensuing session :—

President—W. A. Tilden, D.Sc., F.R.S.

Vice-Presidents who have filled the office of President—H. E. Armstrong, Ph.D., LL.D., F.R.S.; A. Crum Brown, D.Sc., LL.D., F.R.S.; Sir W. Crookes, F.R.S.; James Dewar, M.A., LL.D., F.R.S.; A. Vernon Harcourt, M.A., D.C.L., F.R.S.; H. Müller, Ph.D., LL.D., F.R.S.; W. Odling, M.A., M.B., F.R.S.; W. H. Perkin, Ph.D., LL.D., F.R.S.; J. Emerson Reynolds, Sc.D., M.D., F.R.S; Sir H. E. Roscoe, LL.D., F.R.S.; W. J. Russell, Ph.D., F.R.S.; T. E. Thorpe, C.B., LL.D., F.R.S.; A. W. Williamson, LL.D., F.R.S.

Vice-Presidents—Wyndham R. Dunstan, M.A., F.R.S.; P. F. Frankland, LL.D., F.R.S.; David Howard; Herbert McLeod, F.R.S.; Raphael Meldola, F.R.S.; H. A. Miers, D.Sc., F.R.S.

Secretaries—A. Scott, M.A., D.Sc., F.R.S.; W. P. Wynne, D.Sc., F.R.S.

Foreign Secretary—Sir W. Ramsay, K.C.B., LL.D., F.R.S.

Treasurer—Horace T. Brown, LL.D., F.R.S.

Other Members of Council—J. J. Dobbie, M.A., D.Sc.; Augustus E. Dixon, M.D.; M. O. Forster, Ph.D., D.Sc.; A. Harden, D.Sc., Ph.D.; J. T. Hewitt, M.A., D.Sc.; C. A. Kohn, Ph.D., B.Sc.; J. E. Marsh, M.A.; E. J Mills, D.Sc., LL.D., F.R.S.; S. U. Pickering, M.A., F.R.S.; S. Ruhemann, M.A., Ph.D.; J. A. Voelcker, Ph.D.; James Walker, D.Sc., F.R.S.

Anniversary Dinner.

The Anniversary Dinner of the Society took place at the Whitehall Rooms on Wednesday, March 25, at 7 p.m., when the Fellows and their guests dined together.

The President, in proposing the loyal toasts, said that when the Fellows of the Chemical Society last dined together they were mourning the loss of their great and venerable Queen, and were engaged in a sanguinary war. To-day they were in happier circumstances; the war cloud had disappeared, and that other cloud of suffering through which the King had to pass after his Accession was now but a memory. They might therefore now rejoice and join with new meaning in the old cry of "Long live the King."

Professor Thorpe, in proposing the toast of the Houses of Legislature, said that the theme offered many tempting possibilities. All would admit that both Houses showed an intelligent appreciation of the important part science plays in the conduct of human affairs nowadays, and in directing human development, even to the extent of preserving the national existence of the people for whom these Houses have to legislate.

Now, the House of Lords is singularly fortunate in that it possesses three at least of the most distinguished representatives, not only of British science, but of the science of the whole world—Lord Lister, Lord Rayleigh, and last, but not least, Lord Kelvin, whom we have the honour and pleasure of welcoming here to-night.

It was a circumstance unique in the history of any legislative assembly that there should be at one time three men of such world-wide prominence in the councils of any nation. In France such a thing does not happen; nor even in Germany, so often held up to us as an example of what should be in the relations of the State to science. The House of Commons is not so rich in scientific ornaments. It is true that she possesses in the person of the Secretary of the Royal Society, the Member for the University of London, a man who is a host in himself. As for Sir Herbert Maxwell, like Lord Kelvin, he is no stranger within our gates. His position as a literary man is well known to all. It does not seem to matter to him whether he is chronicling the achievements of some great master in the art of war or of some great master in the art of painting. On history, biography, fiction, natural history, his busy pen has left its mark. He is known in yet another sphere of action to several who are here to-night, and who have had the honour and pleasure of sitting under him on certain departmental committees in which, as a member of the Legislature, he has taken a leading part. Although all may not have seen the results of these inquiries from the same point of view, all are agreed in tendering Sir Herbert Maxwell their appreciation of his urbanity, courtesy, impartiality, and knowledge of procedure.

In responding for the House of Lords, Lord Kelvin pointed out the blood-relationship which exists between the peerage and modern chemistry, for was not the Hon. Robert Boyle "the father of modern chemistry and brother of the Earl of Cork?" But without straining this relationship too far, there was much in modern science which linked it to the peerage. We have the Marquis of Worcester with his steam-engine, Baron Napier and his logarithms, the Hon. Robert Boyle, Cavendish who added so enormously to our knowledge of electricity and chemistry, and who obtained argon as a bubble the size of a pin's head by burning the nitrogen of the air with oxygen, Lord Rayleigh, who has made litres and litres of argon, Lord Salisbury, Lord Blythswood, and Lord Lister. But it was not only because the House of Lords contained many scientific men, but because, as Professor Thorpe had remarked, it was a working and a useful part of the Legislature of the British Empire, that he had to thank them for the toast. As for himself, he would like to say that all his life he had tried to be a chemist. Physical chemistry and chemical physics make up the whole of science outside of biology, at the present day. A great deal has been heard of physical chemistry. With some modifications of its fundamentals, it had come to stay. We must now all be chemists, for chemistry is *the* science of the whole of matter. Gravitation has shown us great things at great distances. Cavendish pushed down the law of gravitation to small distances, but now we must go on down to infinitely smaller distances in connection with chemical affinity, which Cauchy supposed could act at distances infinitesimal with regard to the wave-length of light. The physicist must bow to the chemist to investigate these things. The largest part of physical science is chemistry, and the chemistry of the future is the whole of physical science.

Sir Herbert Maxwell, in replying for the House of Commons, said that in spite of all the kindliness infused into his allusions to the House of Commons, Professor Thorpe had given the impression that the atmosphere of the House of Lords was a purer and a loftier one. And so it is, but is that independent of the fact that so many of those who sit there have passed through the purgatory of the Lower House? Such are Lord Blythswood, Lord Avebury, better known as Sir John Lubbock, and many

others. When the connection between science and the Legislature was mentioned, he feared lest the proposer of the toast was going to contrast what was done in this country for science with what was done in other countries. At the present time, for example, he was chairman of a departmental committee to inquire into the administration of the meteorological grant, which amounts to £15,000. In the United States the grant for a similar purpose is a quarter of a million. Although all the members of the committee appointed by the Privy Council to inquire into the working and amendment of the Pharmacy Acts did not put the same construction on the evidence brought before them, each was ready to give to every other full credit for the faithful discharge of duty according to his lights. Had the report depended on himself alone, he would have felt serious misgivings, especially after many letters he had received from members of a very important profession, but he was much indebted to the Chemical Society for the aid rendered to him by its ex-President, Professor Thorpe, its President-elect, Professor Tilden, and Dr. Stevenson. When it is considered how largely the use of poisonous substances has increased in agriculture, horticulture, and various other industries, he thought they were justified in coming to the conclusion that some relaxation of the restrictions imposed by the Pharmacy Act of 1868 had become urgent.

SIR W. T. THISELTON-DYER said that it was with great pleasure that he proposed the toast of "Prosperity to the Chemical Society," especially as he had to couple with it the names of two great friends of his, those of the President, Professor Emerson Reynolds, and the Honorary Secretary, Professor Dunstan. To the former he owed much for introducing him many years ago to the society of the scientific men of the Irish capital, who were bound together by a *camaraderie* unknown in London. He understood that the President during the tenure of his office had travelled something like sixteen thousand miles in the performance of his duties. The Senior Secretary, whose scientific work he so highly appreciated, gives up his office after a decade spent in the service of the Society, and leaves work much more congenial to him to devote his energies to the task of co-ordinating the Imperial Institute into something useful to the Empire, in which he would have the hearty co-operation of Kew. There must be something in the science of chemistry which for its own sake can call forth such enthusiasm and energy. When the Society meets a century hence, he could conceive that they would look back on the chemistry of the present time much as the transcendental mathematician looks on the arithmetic of the Board school. The chemistry of to-day is probably only the expression of a particular view of material structure—a mere calculus which may be dispensed with. The dream of his old teacher, Sir Benjamin Brodie, may yet be realised, and we may not only be able to say what compounds are possible, but be able to predict their properties, their structure, their form. But what is to be said with regard to life? Lord Kelvin long ago suggested that it came from the stars. After some work with which Professor Dewar had kindly associated his name, he had no hesitation in saying that he could see no difficulty in protoplasm passing through stellar space even though it could not be reduced to chemical laws.

The PRESIDENT said he rose with very mingled feelings to respond. He did not know that he could claim that chemists as a body were particularly modest, but he thought that he might justly claim that the Society which was represented here to-night did admirable work and did it well. There was no harm in proclaiming that the Society was prosperous; its Fellows numbered 2471, and its income has reached the respectable sum of £6200, which has enabled it to print a very large amount of work contributed by its Fellows, many of whom, in addition, it has been able to aid in a material way in the prosecution of their researches. They had always the certainty that truth acquired for its own sake would become of ultimate value to the human race. Now nothing contributes so much to the success of work in any department of human knowledge as a good working hypothesis. It is therefore interesting to note that they were in a measure celebrating the Centenary of the promulgation of the Atomic Theory. That great inspiration of Dalton's with regard to the discrete nature of matter seems to have been first made known in a tentative form to a select audience of nine persons. Now the whole world is the audience of the philosopher. It was invented to explain the chemical laws then known, and had exercised a most profound influence on the progress of science. It was the germ of that molecular theory of matter which pervades all chemistry and physics at the present time. Physicists seemed to expect them to think that all light and leading flows through them, and many considered that Dalton's theory has had its day, but he agreed with Lord Kelvin that it had a long day yet.

Professor DUNSTAN expressed the great gratification it had been to him to be officially connected for the last ten years with the Society, which continues to grow from year to year, and reflects not only the progress of English chemistry, but of the science of chemistry throughout the world. One circumstance he would always recall with the greatest pleasure, and that was the harmonious way in which the officers had always worked together in promoting the best interests of the Society. All acknowledge how much chemistry owes to Germany, and here to-night is to be seen, for the first time by the Society, the bust of Liebig, to whom, both as a discoverer and as a teacher, our science is indebted so much. This gift, which will soon adorn the rooms of the Society, they owed to the generosity of Dr. Messel.

The PRESIDENT-ELECT, Professor TILDEN, said that the pleasant duty of proposing the health of their guests had been assigned to him. Beside those whom they had had the pleasure of hearing, he might mention that they had with them the Director of the National Physical Laboratory, who was, also, most appropriately President of the Physical Society, the President of the Pharmaceutical Society, and the President of the Institute of Chemistry. He could assure the last named that although at one time it was feared that the Institute of Chemistry might interfere with the progress of the Chemical Society, he could assure its President that the Chemical Society looked with friendly eyes on its efforts to raise the qualifications of professional chemists, and to inculcate among its members those professional feelings with which every well-organised profession ought to be animated.

A secret which he had reserved for himself had been let out by Professor Dunstan. The bust of Liebig which they saw was said to be a faithful representation of the great master to whom the science of chemistry owed so much, and who was well-known in England forty-five years ago. Has he come back, like the statue of the commander in *Don Juan*, to remind us of our misdoings? For in 1837 Liebig wrote that he had been staying for a long time in England and had not learned much. He thought that could an opinion be obtained from him now it would be very different, for since that time vast revolutions had taken place. In this country we are always a little late in starting, but when we do start we do our work thoroughly; and he thought that the activity, energy, enthusiasm, and quality of the work done by the Society was not surpassed by any other society on the face of the globe. He had been instructed to couple with this toast the names of Mr. Kempe, Treasurer of the Royal Society, and that of his old friend and pupil, Mr. Swinburne, President of the Institution of Electrical Engineers. He might say that with regard to the Royal Society the Chemical Society looks towards it much as a daughter looks towards her mother even after she has left the parental roof. The acquisition of the three magic letters F.R.S. is still the ambition of all the young

chemists of England, an ambition which has a very healthy influence as an incentive to the pursuit of scientific work. He hoped it would always be reserved as a prize for the successful worker, and awarded solely for additions to knowledge. Circumstances tempted him to ask them to join with this toast yet another well-known name, that of one of the Fellows of the Society, whose appearances are so rare that he comes almost with the prestige of a Foreign Member. All used to look upon Professor Lunge as an Englishman, but whatever he is now he trusted that he retained some kindly thoughts of bygone days spent in England.

There were two reasons Mr. Kempe thought, why he had been asked to respond to this toast—one because he was the senior officer of the Royal Society present, and the other because he represented the law; but he was not on that account going to give them a speech of double length. To-night they had been brought together by the forces of chemical affinity, but soon the forces of dissociation must come into play; still, he ventured to hope that soon again the processes of synthesis would be re-established.

Mr. Swinburne said that it was very pleasant to have his old master, Professor Tilden, propose his name as one of their guests to-night. If, as a boy, he had ever any chemical microbes in him, it was by Professor Tilden that they had been fostered. Although all knew how unsafe it was to differ from Lord Kelvin on any point, he was going to claim chemical science as a small branch of that domain of science which he had the honour to represent, because the *Encyclopædia Britannica* says, and therefore it must be so, that all chemical action is but electrolysis. The foundations of chemistry have, on the whole, been more secure than those of most other sciences during these troublous times. Chemists did not suffer so much as electricians did, for they used to have one fluid, then two fluids, and now no fluid. They had to master a new theory almost every week or two. If there was one piece of advice he might be allowed to give, it would be to stick fast to their atoms and molecules.

Professor Lunge said that he had been greeted by the President-elect as a guest, and in one sense he was so. He had the honour of being elected a Fellow of the Society thirty five years ago, but had never been able until that day to be present at a single meeting. When he was elected he resided in the far north, and his visits to London were few and far between, and now that he was in Zurich they were naturally still more rare, yet he never came to London without looking to see whether he could not attend a meeting of the Society. Now to-day he had been able to attend the Annual General Meeting, and had hoped to be formally admitted a Fellow. He found, however, that that was against the Bye-laws, for it was only at Ordinary Scientific Meetings that Fellows could be admitted. He was therefore just where he was before, and so far entitled to be considered as a guest. Since the freedom of Zurich had been conferred upon him he had become a citizen of Switzerland, but he always felt himself to be what Professor Tilden called him—an English chemist. Whatever he had done he owed to his twelve years of English training, so he owed a debt of gratitude to this country, and he was glad to have this opportunity of saying so and of thanking them for the kind way in which he had been received.

Iron and Steel Institute.—The Annual Meeting of the Institute will be held, by kind permission, at the Institution of Civil Engineers, Great George Street, Westminster, on Thursday and Friday, May 7th and 8th, 1903, commencing each day at 10.30 a.m. The Autumn Meeting will be held at Barrow-in-Furness during the first week in September. An influential reception committee has been formed, with His Grace the Duke of Devonshire, K.G., as Chairman.

NOTICES OF BOOKS.

Tests and Reagents, Chemical and Microscopical, known by their Authors' Names; together with an Index of Subjects. Compiled for the Use of Chemists, Microscopists, Pharmacists, Students, &c. By Alfred I. Cohn. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1903. Pp. iii.—383. 8vo.

The author of this convenient manual is well known by his work "Indicators and Test Papers," which is already in its second edition. In preparing the present volume he has made use of the analogous pamphlets by Altschul, Schneider, and Wilder, as well as the material published in *Merck's Report* during the last three years.

The book is practically a dictionary of those tests known by their authors' names; it is alphabetical, with a subject-index of forty pages, forming an invaluable work of reference as it is, but would be of far greater value had Mr. Cohn thought it possible to append to each test a reference to the original paper in which it appeared, with the date. With the exception of occasional references to Fresenius and one to *The Analyst*, bibliographic data are entirely lacking. H.C.B.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

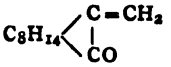
Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 12, March 23, 1903.

Combination of Carbon Dioxide and Potassium Hydride.—Henri Moissan.—The author finds during a synthesis of the alkaline formates an example of the part which a very small quantity of water plays in a reaction. He proves experimentally that from $-85°$ to $+54°$ potassium hydride does not combine with absolutely pure gaseous carbon dioxide. During this interval of temperature the trace of water corresponding to the vapour tension of ice at $-85°$ is sufficient to start the reaction, owing to the heat which is evolved by the violent decomposition of a very small quantity of the alkaline hydride. After once starting enough heat is evolved to continue the reaction, and the change rapidly becomes total. During his experiments on the ordinary combination of carbon dioxide and the hydride, the influence of this trace of water is unimportant.

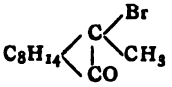
Catalytic Decomposition of Ethylic Alcohol by Finely Divided Metals; Regular Formation of Aldehyde.—Paul Sabatier and J. B. Senderens.—The authors find that the decomposition of ethylic alcohol into hydrogen and aldehyde is effected at a comparatively low temperature by means of copper. There is, in this case, no simultaneous formation of ethylene and no separation of water. The intervention of an oxide produced by reduction of water vapour is absolutely inadmissible, since there is no water vapour, and even if there were copper at $850°$ would be absolutely incapable of reducing it. The authors believe that the decomposition of the alcohol is caused by the production of an unstable metallic hydride which under certain conditions provokes the hydrogenation of the products. This action is supposed to be catalytic and will act in the case of many primary and secondary alcohols.

Barium Sub-salts.—M. Guntz.—The author investigates the action of sodium on the halogen compounds of barium and prepares the sub-salts BaI NaI, BaBrNaBr, BaClNaCl, BaFNaF, salts which have never been obtained before. If these salts are heated in vacuo to about $700°$, the sodium volatilises, leaving the ordinary halogen compound, for example, $BaClNaCl = BaCl_2 + Na$.

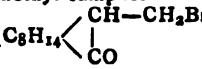
Methylmonobromo-camphor, Bromomethyl-camphor, and Methylene-camphor.—J. Minguin.—By a modification of M. Haller's method the author prepares methylene-camphor—



and from this the bromine derivative—



and again, bromomethyl-camphor—



Hydration of Acetylenic Acids. New Method of Synthesis of the Acids and the Non-substituted β-Ketonic Ethers.—Ch. Moureu and R. Delange.—A classic method of synthesising acetones corresponding to the general formula $R—CO—CH_2—R'$ consists in fixing the elements of water on to the acetylenic hydrocarbons, $R—C\equiv C—R'$. The authors apply this reaction to acids possessing an acetylenic function in addition to the carboxyl ($R—C\equiv C—CO_2H$) in order to convert these into ketonic acids, $R—CO—CH_2—CO_2H$ or $R—CH_2—CO—CO_2H$. Such a reaction takes place in a perfectly satisfactory manner by the action of caustic alkalis. The oxygen of the water fixes itself on to the acetylenic acids in the β position with regard to the carboxyl. Such a reaction gives, therefore, a new method of synthesising the non-substituted β-ketonic acids, $R—CO—CH_2—CO_2H$.

Action of Phosphorus Trichloride on Glycol.—P. Carré.—The action of phosphorus trichloride on glycol causes the formation of 70 to 75 per cent of the product $P_2(OCH_2)_4Cl_2$. The trichloride or the evolved hydrochloric acid act also as a chlorinater, forming glycol chlorohydrine, which itself takes part in the reaction, giving the compounds $PCl_2OCH_2—CH_2Cl$ and $P.Cl.OH.OCH_2CH_2Cl$; this latter compound being insoluble in anhydrous ether, the other two being soluble. At the same time a small quantity of phosphorous acid is formed. These products are decomposed by water, hydrochloric acid being liberated. The first gives a phosphorous ether, $P_2(OCH_2)_4(OH)_2$, which is very unstable, easily losing 1 mol. of glycol when acted upon by water, and giving the ether $P_2(OCH_2)_2(OH)_4$. These two ethers behave as di-acids towards helianthine and phthalein. The latter gives phosphorus ether and glycol chlorohydrine, acting towards helianthine and phthalein as a mono-acid. These compounds are both slowly saponified by cold water, and rapidly by boiling water.

Action of mixed Organo-magnesium Compounds on Amine Compounds.—Louis Meunier.—The mixed organo-magnesium compounds described by Grignard react on ammonia, and the primary and secondary amine groups, borrowing an atom of hydrogen to form the carbide corresponding to the organo-magnesium compound, and substituting in its place the monovalent radical, MgX (X being a halogen element).

Pyrogallol-sulphonic Acids.—Marcel Delage.—In a previous paper the author described the two pyrogallol-sulphonic acids and their principal salts, especially those of barium and calcium. He now describes the preparation and properties of the strontium salts of the same two acids.

MISCELLANEOUS.

Royal Institution.—On Tuesday next (April 21st), at 5 o'clock, Prof. Allan Macfadyen will deliver the first of three lectures at the Royal Institution on "The Blood and some of its Problems"; on Thursday (April 23rd), at the same hour, Prof. Dewar commences a course of three lectures on "Hydrogen—Gaseous, Liquid, and Solid"; and on Saturday (April 25th), at 3 o'clock, Prof. Langton Douglas begins a course of two lectures on "The Early Art of Siena." The Friday Evening Meetings will be resumed on April 24th, when the Hon. R J. Strutt delivers a discourse on "Some Recent Investigations in Electrical Conduction"; on May 1st the discourse will be delivered by Prof. W. J. Pope on "Recent Advances in Stereochemistry"; and on May 8th, by Mr. Rider Haggard on "Rural England."

MEETINGS FOR THE WEEK.

TUESDAY, 21st.—Royal Institution, 5. "The Blood and some of its Problems," by Prof. Allan Macfadyen, M.D., &c.

WEDNESDAY, 22nd.—Society of Arts, 8. "Modern Bee-Keeping," by Walter Francis Reid, F.C.S.

—— Chemical, 5 30. "The Velocity and Mechanism of the Reaction between Potassium Ferricyanide and Potassium Iodide in Neutral Aqueous Solution," by F. G. Donnan and R. le Rossignol. "A Microscopic Method of Determining Molecular Weights," by G. Barger. "Note on the Spectrum of Pilocarpine Nitrate," by W. N. Hartley. "Isomeric Change of Dipropionanilide into Propionyl-β-aminopropiophenone," by F. D. Chattaway. "Note on the Formation of the Di- and Hexamethylammoniacal Chlorides of Cadmium," by W. R. Lang.

THURSDAY, 23rd.—Royal Institution, 5. "Hydrogen—Gaseous, Liquid, and Solid," by Prof. Dewar, F.R S., &c.

—— Society of Arts, 4 30. "The Province of Sind," by Herbert Mills Birdwood, C.S.I., M.A.

FRIDAY, 24th.—Royal Institution, 9. "Some Recent Investigations on Electrical Conduction," by the Hon. R. J. Strutt M A.

—— Physical, 5 Exhibition of Elementary Apparatus, by Mr. Croft. "An Electrical Thermostat," by H. Darwin. "Dimensional Analysis of Physical Quantities and the Correlation of Units," by A. F. Ravenshear. "Note on the Dimensions of Physical Quantities," by R. J. Sowter.

SATURDAY, 25th.—Royal Institution, 3. "The Early Art of Siena," by Prof. Langton Douglas, M.A.

ERRATUM.—P. 162, col. 2, line 21 from bottom, *for* "three" *read* "two."

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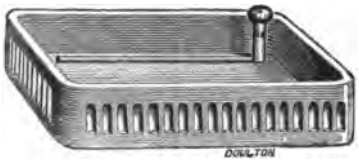

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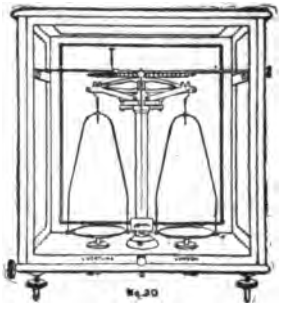

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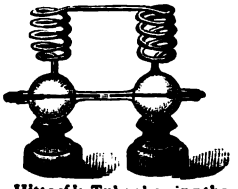

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THE CHEMICAL NEWS

VOL. LXXXVII., No. 2265.

APPLICATION OF THE THEORY OF ELECTRIC BATTERIES TO THE QUANTITATIVE SEPARATION OF METALS.

By A. HOLLARD.

WHEN we plunge a strip of any metal into the saline solution of a more electro-negative metal, the latter is deposited on the former. This constitutes an analytical process and separation well known but rarely applied in quantitative analysis.

As a matter of fact, the deposits obtained are generally spongy, very oxidisable, and difficult to wash. Sometimes, however, the deposit is adherent, but in that case it rapidly and completely emprisons the precipitating metal, and as this latter can no longer go into solution the precipitation is arrested.

We can prevent these drawbacks and make the method quantitative in the following manner:—Suppose that, in a solution containing both nickel and zinc, we wish to precipitate the nickel only, by means of a strip of zinc. We take a vessel divided into two compartments by a membrane of vegetable parchment (sulphurised paper). Into one of these compartments we pour the solution containing both the nickel and zinc (B), and in the other one a saline solution (A), which only needs to be a conductor of electricity, such as a solution of sulphate of magnesium, for example. The strip of zinc for precipitating the nickel must be plunged, not in the solution containing the nickel, but in the solution of sulphate of magnesium. A strip of platinum is placed in solution B, and we connect the platinum to the zinc by means of a copper wire. In this manner we have constructed a double fluid, reversible battery of the Daniell type, in which the current flows from the platinum to the zinc by the copper wire, and from the zinc to the platinum through the solutions. Thus we should produce an electrolysis of the nickel salt, with the deposition of pure nickel on the strip of platinum.

In practice we proceed in the following manner:—The nickel and the zinc, which are both brought to the form of sulphates in solution, are contained in a beaker of 650 c.c. capacity, and 7 c.m. diameter The solution should contain an excess of 20 c.c. of ammonia at 22° B., and 100 grms. of dry sulphate of ammonia, and should occupy about 250 c.c. A cylinder of platinum gauze, 65 m.m. long, 43 m.m., and 35 m.m. diameter at the two ends, is placed in the beaker. A cylinder of glass 55 m.m. diameter, closed at one end by a parchment paper diaphragm, is also placed in the solution so that the diaphragm is as near to the platinum gauze as possible without touching it. This tube forms the internal compartment of the apparatus. A solution of sulphate of magnesium at 250 grms. per litre is poured into this tube until it is 70 m.m. deep. Sulphate of magnesium is chosen in this case, because it is one of the salts that has no chemical action on zinc. Finally, a disk of amalgamated zinc is plunged into this latter solution; it is 5 c.m. diameter, and is held by a copper wire insulated along its length by an indiarubber tube, and connected at the end to the end of the platinum electrode.

The zinc disc is arranged about 15 or 20 m.m. above the parchment, and is pierced with several holes to allow the free circulation of the liquid in the internal compartment. The outer liquid must be kept up to 95° during the operation. After a few hours the nickel is deposited completely on the electrode in a very adherent metallic layer. The electrode is then withdrawn and washed thoroughly, and left for ten minutes in distilled water; it is then dried and weighed.

It may be asked, what are the advantages of this method of separation over the methods given in electrolytic analysis? Electrolytic analysis, in principle, is based on the fact that each metal is deposited at a definite tension of its own—so definitely so, that by gradually increasing the tension of a current passed through an electrolytic cell containing a mixture of metals, the deposition of each one ought to be effected in turn.

In reality, there are cases where the tensions of polarisation of the metals are too close to each other to permit the separation of one of them without the others being carried with it. This is precisely the case with nickel and zinc, which we have never succeeded in separating completely, no matter how feeble the currents used; for example, in ammoniacal sulphate solution the nickel always carries zinc with it; in cyanide of potassium solution, where the order of the tensions is inverted, because of the complex nature of the salts, the zinc always carries nickel with it.

On the other hand, the present method enables us to separate two metals of which the tensions are very close to each other; it is sufficient to make the negative pole with a disc of the metal having the highest tension, and the other metal will be precipitated alone.*

Experimental Results.

	Amount taken. Ni. Grm.	Amount taken. Zn. Grm.	Ni deposited. Grm.
1	0·2000	1·0	0·2026
2	0·2000	0·5	0·1995
3	0·2500	1·0	0·2499
4	0·2500	1·0	0·2525
5	0 5000	0·0	0·4989
6	0·4500	1·0	0·4506
7	0·5000	1·0	0 5048 (contained a little zinc)
8	0·0500	1·0	0·0524

The amounts of nickel and zinc were not weighed, but were measured with pipettes from titrated solutions.

We see from the above table that the method is applicable to any proportions of nickel and zinc; still, the mixture should not contain more than 1 grm. of zinc nor more than 0·45 grm. of nickel, or there is a liability to deposit zinc at the same time as the nickel.

Experiment No. 7 showed that with 0·5 grm. of nickel and 1 grm. of zinc there was zinc carried down with the nickel. When there is no zinc present in the solution, we can deposit at least 0·5 grm. of nickel in the pure state. (See experiment 5).

These limitations of the quantities of nickel and zinc find their explanation in the theory I am about to put forward.

The theory of this present method of separation is no other than that of reversible batteries. The tension of the solution P of the precipitating metal, in this case zinc,† being greater than the tension of solution P′ of the precipitated metal; in this case, the nickel,‡ there is a positive electric tension established between the two metals which can be determined by Nernst's formula:—

$$e = \frac{K}{v} \log \frac{P}{C} - \frac{K}{v'} \log \frac{P'}{C'},$$

* The order of the tensions of the principal metals is as follows, commencing with the highest:—Zn, Cd, Fe, Co, Ni, Sn, Pb, H, Cu, As, Bi, Sb, Hg, Ag, Pd, Pt, Au. This order is the same as that of the electric tensions.

† The idea of *tension of solution* has been suggested in the theory of ions by the analogy that has been established between the tendency the body has to pass to the state of ions and the tendency it also has to pass to the state of vapour. In the same manner that the second has been named vapour-tension, the measurement of the former is called tension of solution.

‡ The order of the tensions of solution is the same as that of the tensions of polarisation given in a previous footnote.

K is a constant for a constant temperature; v and v' are the valences of the precipitating and the precipitated metals, C and C' the concentrations of these two metals.

In the formula we have put C and C', the concentration of the metals, instead of their osmotic pressures p and p', which ought to be inserted, because, C and C' are proportional to p and p', on account of the relatively great dilution of the solutions with which we are dealing.

We see, according to this formula, that when the concentration C of the zinc, in the interior compartment, increases on account of the deposit of nickel on the platinum electrode, e will diminish. Therefore, there should not be too much nickel to be deposited; still we can easily deposit 0·45 grm. According to the same formula, we see see that if the concentration of the nickel diminishes, e tends towards zero, which means that the nickel cannot be deposited entirely.

This is what happens if we take neutral sulphate of nickel, but we have to deal with a solution which contains a large excess of sulphate of ammonia and ammonia; that is to say, a solution containing a large concentration of $\overset{+}{H}$ ions; from this it follows that C' does not represent the concentration of the nickel ions, but a mean between the concentration of the ions $\overset{++}{Ni}$ and $\overset{+}{H}$. This hydrogen is being given off throughout the duration of the electrolysis.

Thus, if we wish to generalise the method for other separations than that of nickel and zinc, care must be taken to have an excess of ammonia or acid, or of some other body capable of forming the ions $\overset{+}{H}$.

In reality, the phenomenon is complicated by the secondary actions, which must always be remembered if we wish to extend the method to other separations than that of nickel and zinc.

1. The concentration of the sulphate of zinc which accompanies the nickel in the solution, must not be too great, for in that case this salt on the one hand, and, on the other, the dilute solution of sulphate of zinc that is formed in the other compartment by the dissolving of the disc of zinc, might constitute a *battery of concentration* (Zn, dilute $ZnSO_4$, Pt, concentrated $ZnSO_4$, Zn and Pt being the poles of the battery; that is to say, the disc of zinc with its wire, and the platinum electrode) sufficiently strong to raise the total electric tension of the system to a point at which the zinc might be precipitated with the nickel; this is what we have observed when the solution of nickel contained 2 grms. of zinc and over. For this reason we recommended above not to have more than 1 grm. of zinc in the solution of nickel.

2. The sulphate of zinc formed in the solution of sulphate of magnesium by the solution of the zinc, attacks the zinc disc, especially when heated; there we get a voltaic couple which produces another increase of electric tension, an increase which we have kept as low as possible by arranging to have the compartment containing the zinc disc in the coolest part of the apparatus. The concentration of this sulphate of zinc increases gradually as the nickel is deposited, and this augmentation increases the attack on the zinc disc, and consequently the tension of the voltaic couple, which eventually causes the precipitation of the zinc with the nickel. Fortunately this increase of concentration at the same time causes the tension of the battery of concentration to decrease, as well as the tension of the principal battery (see Nernst's formula above), so that we can deposit up to 0·45 grm. of pure nickel, even when the solution of nickel is accompanied by 1 grm. of zinc. When the nickel is alone, we can get a much greater deposit, for in this case there is no battery of concentration. From what has preceded it results that the amount of nickel deposited in the pure state may be the greater in proportion as the nickel is accompanied by less zinc (for then the effect of the battery of concentration is reduced in like proportion), and inversely, that the amount of zinc that accompanies the nickel may be all the greater as the nickel is less (for then the effect of the voltaic battery is reduced in like amount). By never exceeding 0·45 grm. of nickel and 1 grm. of zinc in the solution, we can be always certain of obtaining pure nickel.

3. Finally, there is another secondary phenomenon which is not produced by sulphate of zinc, but which may occur with a certain number of salts, so it is as well to examine it in order that our discussion of this method may be complete. We mean the transportation of these salts, during electrolysis from the cathode (here the platinum) to the anode (here the precipitating metal). This is called Hittorf's phenomenon. It is necessary, therefore, to see with regard to each metal whether it forms a salt not submitting to Hittorf's phenomenon, and if it is preferable to work at any one temperature rather than another, for the loss of concentration round the cathode (and round the anode) varies with the temperature. Thus the method cannot be applied to the whole category of salts. There can be no question especially of applying it to sulphate of copper, the ions $\overset{++}{Cu}$ passing from the anode very rapidly.—*Bull. Soc. Chim.*, Series 3, vol., xxix., No. 3.

A METHOD OF FREEING COMMERCIAL METHYLATED SPIRIT FROM MINERAL OIL.

By A. P. IBBOTT.

Commercial methylated spirit contains, in addition to aldehydes and other removable substances, a certain amount of mineral oil. Apart from these impurities, methylated spirit might be used by the chemist for the large majority of his operations in place of the costly ethyl alcohol. Where ethyl alcohol reacts with other substances to form a desired product none but the pure ethyl alcohol must be used, but in the large number of cases where it is employed as a solvent, and for crystallisations, the presence of a small quantity of methyl alcohol is usually harmless, and pure methylated spirit might be used at a fraction of the cost of absolute alcohol.

Pure methylated spirit is, however, impossible to obtain unless under conditions which are impracticable except to those who employ it on a very large scale. A method is well known for removing the aldehydes, &c., which consists in distilling the spirit with caustic potash, followed by treatment with an oxidising agent, such as potassium permanganate or bichromate.

The mineral oil remains, however, after this treatment, and if such partially purified spirit is diluted with water the oil is thrown out of solution, and appears in suspension, rendering the liquid quite opaque. The presence of this oil unfits it for all the ordinary purposes of the chemist. The oil will not, in any reasonable time, separate in a layer so as to allow of the spirit being drawn off by means of a separator, and filtering is useless, as the particles of oil pass through the closest-grained filter-paper.

If, however, the mixture of spirit and water is saturated with common salt, and then filtered, the resulting filtrate is found to be perfectly clear. Methylated spirit may therefore be freed from mineral oils by this method, the cost of which is infinitesimal.

The methylated spirit, after treatment with caustic potash, &c., as above, is diluted with two and a-half times its bulk of water, enough salt is added to *thoroughly saturate* the mixture, which is then shaken vigorously for five minutes. After standing half-an-hour, the mixture is filtered through a paper well wetted with water. The filtrate is clear, and consists of a mixture of brine and spirit, from which a 90 per cent alcohol can be obtained in two fractional distillations. This can of course be further freed from water by the usual methods.

If the distillate should still give a slight milkiness on the

addition of water, it is an indication that sufficient water was not added in the first operation to throw the whole of the oil out of solution, but the quantity stated (two and a-half volumes) is usually sufficient.

From the writer's experiments, it would appear that the salt causes the oil to separate as a layer on top of the mixture of brine and spirit, but the quantity of oil is so small that the layer cannot be distinctly observed. Or possibly the salt causes the particles of oil to cohere into larger particles which will not pass through the filter-paper. In any case, filtration has been found to yield better results than are obtained by using a separator.

ON THE

DETERMINATION OF MOISTURE IN HONEY.*

By FRANK T. SHUTT, M.A., F.I.C., F.C.S.,
and
A. T. CHARRON, M.A.

The investigation which gave rise to the work recorded in this paper was undertaken to ascertain what difference in composition—if any—existed between honey extracted from capped and uncapped comb. Apiarists term the latter immature or unripe honey, and contend that it is of a thin and inferior quality, and, therefore, when placed upon the market, apt to injure the sale of mature or ripe honey taken from fully capped comb. Further. it is held that "unripe" honey materially affects the latter's keeping quality.

Among the first determinations attempted was that of the water-content of the honeys, and the difficulties that were at once met with in obtaining results of a concordant and reliable character led us to examine the various methods now in vogue for estimating moisture in such saccharine substances.

Drying on Asbestos in Glass Tubes at approximately 98° C. in Steam bath.

In all essential features, this method is that recommended by Macfarlane for estimating moisture in milk, butter, and many other articles of food that are already fluid or can be readily brought into this condition. The honey was weighed in a weighing bottle and then washed out into a 100 c.c. graduated flask and made up to the containing mark. An aliquot part of the solution was run into each tube containing a sufficiency of asbestos to act as an absorbent. The tubes were then dried in racks in a steam-oven at atmospheric pressure and maintained at a temperature of (approximately) 98° C. We presume that this is essentially the method and *modus operandi* followed in obtaining the greater number of the results recorded in the *Bulletin* (No. 47) on honey, issued by the Inland Revenue Department, Canada.

Unfortunately, this convenient method proved exceedingly unsatisfactory, it being found impossible to obtain constant results. The longer the period of drying, the greater the loss. Even after five days' drying, the tubes continued to lose in weight—due, undoubtedly, to the continued decomposition (dehydration) of the levulose, which constitutes practically 50 per cent of the saccharine matter of honey.

In the following table we have arranged the moisture-content of twelve samples of honey as determined at the expiration of forty-eight hours, seventy-two hours, and ninety-six hours. In the first series, each tube received 20 c.c. of an approximately 20 per cent solution; and in the second series, 10 c.c. of an approximately 5 per cent solution. The percentages of moisture, as calculated from the specific gravity determination, are also given.

(In all the estimations of moisture and solids, as calculated from the specific gravity of the diluted honey—taken at 15·5° C.—the following formula has been employed:—

$$W = \frac{D - 1000}{3{\cdot}85 \times M},$$

W = Per cent of solids in honey.
D = Density of diluted solution of honey.
3·85 = Increase of density for each 1 grm. of sugar or other carbohydrate in 100 c.c. of the liquid.
M = Grms. of honey in 100 c.c. of diluted solution).

TABLE I.—*Moisture in Honey, as Determined in Steam-bath at 98° C.*

No.	From 20 per cent (approximately) solution.			From 5 per cent (approximately) solution.		Calculated from sp. gr. of diluted honey.
	48 hours.	72 hours.	96 hours.	48 hours.	72 hours.	
	Honey from Fully Capped Comb.					
1.	21·91	22·82	24·17	23·40	25·40	17·93
	20·30	22·19	22·98	25·68	26·48	
2.	21·86	22·38	23·38	25·80	26·20	17·88
	21·17	21·89	23·13	26·28	26·50	
3.	21·56	23·29	24·01	29·40	30·80	18·76
	20·56	21·44	22·76	28·24	29·72	
4.	24·43	24·48	26·27	28·94	30·70	19·55
	23·00	23·70	25·53	29·10	31·10	
	Honey from Partially Capped Comb.					
5.	25·05	26·91	27·73	29·78	31·54	19·49
	24·78	25·78	26 93	31·16	32·28	
6.	27·29	27·86	29·37	32·08	33·80	22·29
	27·56	28·50	29·49	32 18	33·30	
7.	28·41	29·57	30·86	33·80	35·88	23·27
	27·59	28·50	29 59	32 08	34·36	
8.	25·65	27·59	27·66	32·10	33·90	23·92
	26·14	27·63	28·14	33·00	35·72	
	Honey from Uncapped Comb.					
9.	23 68	24·86	25·47	30·40	31·76	19·57
	23·96	24·63	25·32	28·56	30·04	
10.	22 82	24·10	24·88	28·54	29·34	18·25
	23·07	23·98	24 97	28·48	30·36	
11.	23·34	24·65	25·73	27·58	29·76	19·24
	22·87	24·19	25·91	28·76	29·60	
12.	25·59	27·06	27·68	32·26	32·86	22·69
	26·65	28·10	28·58	32·90	34·22	

A detailed consideration of the data is unnecessary, but the more important deductions from them may be briefly stated as follows:—

1. That, assuming the results from the specific gravity determination to be approximately correct, a drying period of forty-eight hours at 98° C. gives too high a percentage of moisture, the excess being about 5 per cent.

2. That the longer the drying period, the greater the loss; that is, the decomposition of the levulose is continuous, This fact, that it is practically impossible to dry to a constant weight, is in itself sufficient to condemn the method.

3. That higher percentages of water are obtained from the 5 per cent than from the 20 per cent solutions of honey, showing that there is a more rapid decomposition of the levulose when using the more dilute solution.

Drying on Asbestos in Glass Tubes at 70° C. to 75° C. in Steam-bath.

Our next step was to ascertain the moisture-content, drying between 70° C. and 75° C.—the other conditions being the same as in the first series. Each tube contained 10 c.c. of an approximately 12 per cent solution of honey. The samples, though corresponding with those of the first series, were not identical with them.

* From the *Transactions of the Royal Society of Canada*, vol. viii, p. 85.

TABLE II.—*Moisture in Honey, as Determined in Steam-bath at 70° C. to 75° C. Solution, approximately 12 per Cent.*

No.	20 hours.	27 hours.	31 hours.	36 hours.	Calculated from sp. gr. of diluted honey.
			Honey from Fully Capped Comb.		
1.	19·36	19·82	20·03	20·07	15·46
	19·95	20·29	20·50	20·90	
2.	19·52	19·87	19·99	20·00	16·95
	18·78	18·88	19·24	19·42	
3.	20·63	20·52	21·29	21·51	15·89
	19·59	20·16	20 67	20·44	
4.	20·20	20·59	21·12	20·91	15·84
	20·07	20·66	20·75	21·07	
			Honey from Partially Capped Comb.		
5.	23·00	23·49	23·87	23·71	19·12
	22·13	22·39	22·67	23·12	
6.	24·89	25·19	25·44	25·46	20·63
	25·41	25·87	26·21	25·91	
7.	25·23	25·46	25·85	26·19	20·68
	24 96	25·26	25·91	26·18	
8.	23·45	23·88	24·59	24·73	21·03
	24·00	24·06	24·78	25·33	
			Honey from Uncapped Comb.		
9.	21·20	21·77	21·69	22·09	17·83
	21·46	21·56	21·81	21·62	
10.	21·26	21·73	21·61	22·00	16·59
	20·69	20·93	21·09	21·00	
11.	21·52	21·79	22·05	22·14	39·42*
	21·70	22·21	22·34	22·09	
12.	20·24	21·11	21·30	20·86	41·20*
	20·40	21·01	21·18	21·22	

* Found to be slightly fermented.

From these data we note that drying, even at this lower temperature (70—75° C.), for a period of twenty hours, gives results much higher than those obtained from the specific gravity estimations; and, further, the percentages of moisture—or rather, of loss—increase with continued heating, though not so rapidly as when a temperature of 98° C. is used (see Table I.).

(To be continued).

ON A METHOD OF DEMONSTRATING NEWTON'S COLOURS BY TRANSMITTED LIGHT.

By H. N. DAVIS.

IT is well known that if white light be passed through a thin film, part of it will be reflected twice within the film and will cause interference and colour phenomena. These are usually very faint because the amount of light that is thus reflected is so small as compared with what passes directly through as to have but a slight effect. If, however, the same wave-front be passed through a uniform series of films, successive portions of certain colours should be blotted out in each film, while other colours which get through the first film without interference, should emerge from each of the other (similar) films without interference, and the colour effect should be cumulative.

At the suggestion of Professor Barus, these surmises have been empirically verified, and excellent results obtained. If a number of wire rings of the same size be mounted in parallel planes, and dipped together into a soap solution, their planes being kept perpendicular to its surface, a suitable series of films results, through which light can be passed and caught on a sheet of paper, showing the desired phenomena very beautifully. Since each film, under the action of gravity, is a very thin wedge, the colours are in horizontal bands, appearing first at the top (where the wedge is thinnest) and moving slowly down across the field as the films evaporate, to be succeeded by other bands of lower orders. Indeed good films will often hold until two-thirds of the field is coloured with the yellowish-brown of the first order. And if the paper be replaced by a good lens, and the colours projected on a large scale upon a suitable screen, they can be strikingly demonstrated to a class. Some of the effects obtained in this way are most magnificent, even rivalling the best of our autumn sunsets, until it is only with reluctance that one concedes the essential dissimilarity between the two phenomena. In practice, the important thing seems to be uniformity in size and alignment in the set of rings. I have found it convenient to make them some 5·5 c.m. in diameter, using galvanised iron wire (d=1·2 m.m.) and forming each around a pattern of wood or metal, the ends being twisted together into a sort of handle. Such rings can be temporarily strung on three rods, notched at appropriate intervals to insure parallelism in the planes of the rings, while the "handles" are being clamped between two pieces of soft wood. The rings should be at least a centimetre apart to avoid cylindrical and irregular films, and from fifteen to thirty are sufficient. A tin trough of such dimensions as just to admit the set facilitates the dipping.

During the course of this experiment, before the films have become thin enough to show colours, certain other phenomena of a circulatory character are very noticeable. These may be studied most easily in the projected image of a single film, and for observations on conditions immediately after formation, it is convenient to support a ring on the shorter branch of a J-shaped "handle" and to fix it permanently in the focus of the projecting lens, a narrow trough being raised so as to submerge the ring when necessary. The moving images are of two kinds, one corresponding to pear-shaped air-bubbles running up at the sides of the film, the other to spheroidal drops running down through the middle. These sets of images are always of opposite colours, and if, under given circumstances, the air-bubbles show white and the drops black, then moving the film some 4 c.m. away from the lens will reverse the colours, the bubbles showing dark and the drops white. From this it is evident that the latter act as convex lenses with real foci (bright spots) some 2 c.m. in front of the film, while the bubbles are concave lenses with virtual foci 2 c.m. behind it.

These air-bubbles require but little explanation, but the drops are more interesting. The happenings in a typical film (dipped at a time t=0) are as follows: At first its image is clear, but almost immediately a few large drops appear at various parts of the film and begin to descend. These "wanderers" are much larger than their successors (d=0·5 or 0·6 m.m.) and their number varies from one to a dozen, being largest when a preceding film has dried on the ring and has not been removed. At t=1 sec. a "skirmish-line" has formed about a third of the way down, above which line the film is closely dotted with drops. This travels down in the film about as fast as do the colour-bands later, reaching the bottom at t=about 8 sec. The drops in its front rank are usually small, but a half a centimetre behind come the largest of the "ordinaries" (d=0·2 to 0·3 m.m.) and after these a succession of smaller ones until (at t=60 to 100 sec.) the film begins to show colours and great viscosity is noticeable. The size of the average drop is some 0·2 m.m. and, roughly speaking, the size of those passing a given point decreases as t increases. The velocity of descent varies from 0 to 7 m.m. per sec. (that of the wave front averaging 5·7 m.m. per sec.) and is greater (1) for large drops, (2) for drops near the bottom of the ring, and (3) at times corresponding to small values of t, but, if other things are equal, is nearly the same at all points in the

same horizontal line. A number of observations gave an empiric formula $v^2 = 2p\,(y-q)$ (y being the distance from the top of the ring, and p and q functions of t, the former decreasing—very rapidly at first—and the latter increasing as t increases). This formula is, of course, a rough approximation, but analogies between it and $v^2 = 2gs$ are very interesting. These "drops" are not simply bulges due to variations in the surface tension of a film (for similar phenomena appear in the image of a thin glass cell filled with solution), but are little globules floating in the liquid, composed of a more concentrated solution with greater density and refracting power, and with a surface tension with respect not only to air but to the rest of the solution; though the process by which such definitely separated globules are formed is not quite clear.

It is not unlikely that further study of the nature, form, and velocity of such descending masses, both in films and in thin cells (where they are spheres and the surrounding medium is stationary) may lead to a method of investigation not only of changes in viscosity due to evaporation, but possibly also of the problems of surface-viscosity, in connection with which further knowledge would be very desirable.—*American Journal of Science*, [4], xv., No. 87.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month Ending March 31st, 1903.

By SIR WILLIAM CROOKES, F.R.S.,
and
PROFESSOR DEWAR, F.R.S.

To Charles Perrin, Esq., M.Inst.C.E.,
Water Examiner, Metropolis Water Act, 1871.

London, April 11th, 1903.

Sir,—We submit herewith, at the request of the Directors, the results of our analyses of the 211 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from March 1st to March 31st inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in previous reports.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 211 samples examined by us during the month, all were found to be clear, bright, and well filtered.

The rainfall at Oxford during the month of March was 3·03 inches; the average fall for March is 1·47 inches, thus showing an excess of 1·56 inches; and the previous deficit of 0·51 inch is converted into an excess of 1·05 inches for the first three months of the year; the excess equals 19·6 per cent on the thirty-five years' average.

The conditions prevalent during the first quarter of the year are the first sign of a return to the normal rainfall in the Thames Valley during the last eight years; the conditions since the year 1895 having been quite exceptional.

The organic matter in solution, chiefly of vegetable origin, during the past month has exceeded the mean average amount of the last ten years. The excess is 20 per cent above the average. This would appear a considerable amount, unless regard is had to the fact that the total absolute amount present, even under the most disadvantageous climatic conditions, is always a small quantity. The present condition, however, is not exceptional, because substantially the same amount of organic matter was present in the Thames-derived waters during the winter months of 1898-9 and 1899-1900.

Unless with a much-increased staff and expenditure, it would be impossible to examine a larger number of samples than the 700 or 800 a month which, up to the present, we have regarded as sufficient to check the daily working of the various Water Companies. During the whole period of our conduct of the chemistry and bacteriology of the London Water Supply, now extending over twenty-three years, we have always acted as a perfectly independent authority, and no interest has been in our case more paramount than that of the water consumers. Our duty has been to endeavour to make the Water Companies work up to the highest efficiency, and we can say with perfect confidence that the general condition of the supply was never more carefully superintended and more satisfactory. The long series of more than 50,000 chemical and 35,000 bacteriological analyses that have been permanently recorded will always be a guide of the greatest importance in governing the operations of purifying the supplies from the Thames and Lea.

Our bacteriological examinations of 360 samples taken during the last month have given the results recorded in the following table. Besides these samples we have examined 225 others from special wells, standpipes, &c., making a total of 585 samples in all:—

	Microbes per c.c.
New River, unfiltered (mean of 26 samples) ..	335
New River, filtered (mean of 78 samples) ..	11
Thames, unfiltered (mean of 26 samples) ..	9337
Thames-derived water, from the clear-water wells of eight Thames-derived supplies (mean of 180 samples)	27
Ditto ditto .. .. highest	212
Ditto ditto .. .. lowest	0
River Lea, unfiltered (mean of 25 samples) ..	582
River Lea, from the East London Company's clear-water wells (mean of 25 samples) ..	29

Of the 283 daily samples taken from the filter-wells of the Metropolitan Water Companies, five samples, or 1·7 per cent, were sterile; fifteen samples, or 5·3 per cent, contained more than 100 microbes per c.c.; and five of these contained more than 150. The mean number of microbes in the samples containing more than 100 per c.c. was 136, against a corresponding mean of 144 in the 3·2 per cent excess samples of the month of February.

Practically the water has maintained the same bacteriological condition as it had last month.

We are, Sir,
Your obedient Servants,
William Crookes.
James Dewar.

Optical Properties of the Oximidocyanacetic Ethers.—P. Th. Muller.—The optical examination of these bodies leads to one or the other following alternatives:—1. Either the nitroso-cyanised derivatives do not possess the constitution attributed to them; that is to say, they do not contain, at the same time, the radicals CN and NOH or NOR. It appears, however, from their synthesis from nitrous acid and the cyanacetic ethers that we cannot give them any other formula than NC—C—COOR and NC—C—COOR. 2. On the other hand, and this is the conclusion we have adopted, the two negative nitro-radicals CN and NO, have a mutual influence in raising their refractive power as well as their dispersive power. The double bond between the carbon and the nitrogen possibly plays a definite part, as has been observed before in other cases.—*Bull. Soc. Chim.*, Series 3, xxviii., Nos. 20—21.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, April 2nd, 1903.

Prof. W. A. Tilden, D.Sc., F.R.S., President, in the Chair.

Messrs. T. E. Wallis, R. C. Farmer, and H. W. Bywaters were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. William Godsell Burghard, 180, High Holborn, W.C.; Edwin Jesse Fairhall, 29, Winsham Grove, S.W.; Norbert Van Laer, 69, Calais Road, Burton-on-Trent; Henry Wolff Levy, Chancery Lane, Melbourne; Alfred Ernest Moore, B.A., B.Sc., St. John's College, Battersea, S.W.; George M. Norman, B.Sc., 5, Watford Villas, Battersea Park, S.W.; George Harry Parry, The Level, Brierley Hill, Staffordshire; James C. Smith, B.Sc., 57, Great Ormond Street, W.C.

Of the following papers, those marked * were read:—

*51. "*The Dioximes of Camphorquinone, and other Derivatives of* Isonitrosocamphor." By M. O. Forster.

The dioximes of camphorquinone, three of which were described by Manasse (*Ber.*, 1893, xxvi., 243), have been obtained in purer condition, and the series of four completed. The following table summarises the chief characteristics of these substances:—

	M. p.	$[\alpha]_D$ in alcohol.	$[\alpha]_D$ in 2 per cent sodium hydroxide.	Precipitate with sodium hydroxide and ferrous sulphate.	C.c. of absolute alcohol at 20° required to dissolve 1 grm.
α-Dioxime ..	201°	−63·6°	−98·3°	Chocolate	40
β Dioxime ..	248	—	−24·1	Chocolate	590
γ-Dioxime ..	135	+22·4	+12·6	None	1·0
δ-Dioxime ..	199	+75·5	+83·6	Chocolate	12·4

The *peroxide* of the dioximes, $C_{10}H_{14}O_2N_2$, obtained by oxidising them with potassium hypobromite, melts at 144·5°, and when reduced with zinc and acetic acid, yields the α-dioxime.

The *anhydride* of *iso*nitrosocamphor, $C_{20}H_{28}O_3N_2$, prepared by heating together the potassium and benzoyl derivatives of *iso*nitrosocamphor in benzene, is also formed when benzoyl chloride, acetyl chloride, phosphorus oxychloride, or acetic anhydride acts on the dry alkali derivatives. It melts at 187°, becoming transformed into the anhydride of α-camphornitrilic acid; a 2 per cent solution in chloroform has $[\alpha]_D$ +141·7°.

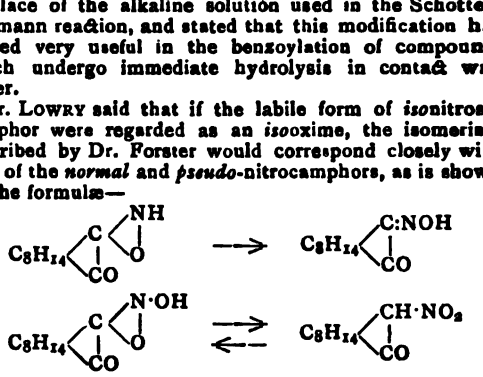
Two isomeric *compounds*, $C_{17}H_{18}O_5N_2$, melting at 136—137° and 152° respectively, are produced by the action of *m*-nitrobenzoyl chloride on an alkaline solution of *iso*nitrosocamphor. As in the case of the benzoyl derivatives, the substance of lower melting-point is yellow, whilst the other is colourless. On hydrolysis, the former gives rise to a new modification of *isonitrosocamphor*, $C_{10}H_{15}O_2N$; this compound, which is still under investigation, melts at 114° and passes into the known isomeride between that temperature and 152°.

Discussion.

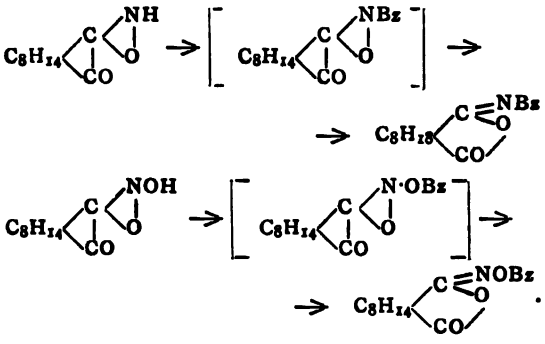
Dr. Armstrong pointed out that if Dr. Forster's discovery of a yellow benzoyl*iso*nitrosocamphor were taken into account, together with Miss Whiteley's recent important observations on the colour of oximic compounds, the absence of colour from *iso*nitrosocamphor and the dioximes could only be explained—if they were regarded as true oximic compounds—on the assumption that they were polymerised molecules; but he was of opinion that it was premature, at present, to accept the explanation afforded by the Hantzsch-Werner hypothesis of the isomerism subsisting among the dioximes. On various grounds, he held this hypothesis to be open to grave question. Even the structure of camphorquinone appeared to be by no means placed beyond doubt.

Dr. Silberrad asked whether the benzoylation of camphor*iso*imide had been tried in perfectly dry pyridine in place of the alkaline solution used in the Schotten-Baumann reaction, and stated that this modification had proved very useful in the benzoylation of compounds which undergo immediate hydrolysis in contact with water.

Dr. Lowry said that if the labile form of *iso*nitrosocamphor were regarded as an *iso*oxime, the isomerism described by Dr. Forster would correspond closely with that of the *normal* and *pseudo*-nitrocamphors, as is shown by the formulæ—



The formation of a colourless benzoate might then be regarded as being due, in each case, to the benzoylation of the labile form with an accompanying isomeric change of the Beckmann type:—



Dr. Forster stated that the molecular weight of the new *iso*nitrosocamphor had not been determined, but that as soon as the necessary material had been accumulated the general behaviour of the substance would be more closely studied; Dr. Silberrad's suggestion relating to camphor*iso*imide would be adopted.

*52. "*Reversibility of Enzyme or Ferment-action.*" By A. C. Hill.

It has been shown previously that the hydrolysis of maltose to glucose by yeast extract in concentrated solution is incomplete, the phenomena being due to polymerisation of the glucose by a reversible process, and a point of equilibrium is approached which varies with the concentration of the total sugar. In further publications, it was also pointed out that the polymerisation of glucose resulted in the formation of isomeric sugars, and somewhat different results were obtained when Taka-diastase and the pancreatic ferments respectively were used instead of yeast extract. In every case, it was possible, by diluting solutions of the synthetical products, to hydrolyse these compounds back to glucose by the enzyme used in their synthesis. Further, it had been found that the synthetical products of the action with yeast extract are hydrolysed by Taka-diastase, and those of the action with Taka-diastase by yeast extract.

When the products of the synthetical change obtained by the use of yeast ferment, whilst still mixed with unchanged glucose, are fermented with *S. Marxianus*, only this hexose is fermented; but when a yeast containing maltase is employed, a part also of the synthetical product is fermented. Again, if the synthetical products in dilute solution are submitted to the hydrolytic action of yeast extract and then treated with *S. Marxianus*, the

whole is fermented. The sugar that is not fermented either by *S. Marxianus* or by yeasts containing maltase has been separated and proves to be a new biose, which is called *revertose*. The other sugar, which is fermented by all yeasts containing maltase, but not by *S. Marxianus*, is believed to be maltose, for although it has not been obtained pure, yet on fractionating mixtures of this sugar with revertose, specimens have been obtained in which the former sugar preponderates and of which the optical and other properties approach those of maltose. Its osazone crystallises in plates, whilst the corresponding derivative of revertose separates in needles. Revertose is formed in larger quantity, and the equilibrium point of glucose $\rightleftarrows$ revertose is more favourable to the synthetical change than the equilibrium point of maltose $\rightleftarrows$ glucose, which favours the hydrolytic reaction.

The products of the synthetical change with Taka-diastase are equally fermentable in part by all maltase-containing yeasts, and, as previously indicated (*Proc.*, 1901, xvii., 184), are readily re-hydrolysed by the same ferments in dilute solution. These products have not been separated.

Since the first paper on this subject (*Trans.*, 1898, lxxiii., 634), further observations of a similar nature have been made by the author and others, and the number of ferments for which a reversible action has been noted has become extended. These results warrant the adoption of the hypothesis that all ferment actions are reversible.

Discussion.

Mr. A. R. Ling said that recent experiments on the action of various hydrolytic enzymes on polysaccharides had shown that hydrolysis was invariably accompanied by a reversed or synthetical action, Dr. Hill being the first to notice that this reversion occurred when a concentrated solution of *d*-glucose is submitted to the action of yeast maltase.

In conjunction with Mr. B. F. Davis, he had obtained evidence that a certain amount of reversion occurred at a certain stage in the reaction between malt diastase and 3 per cent starch paste.

The use of the term "reversion" was, however, scarcely justifiable, as in no case had reversion led to the regeneration of the original carbohydrate, the products being *iso*-sugars, as had been shown in certain instances by E. Fischer and E. F. Armstrong. As it was extremely unlikely that the same product was obtained from a given carbohydrate by the use of different enzymes, the name "revertose" seemed too general for any specific compound obtained in this way.

Dr. E. F. Armstrong remarked that the important question to be decided with reference to the synthetical action of enzymes was whether the sugar synthesised was identical or not with that normally hydrolysed by the enzyme, and expressed the view that, at present, the experimental evidence tends to prove that the synthesised biose and the hydrolysed biose bear the same relation to one another as do the α- and β-methyl glucosides. He thought that the portion of the material fermented by yeast was more likely glucose than maltose, and did not consider the evidence sufficient to establish the individuality of revertose as distinct from the *iso*maltose proved by Emmerling to be formed by the action of maltase on glucose.

Mr. J. L. Baker enquired whether any derivatives of revertose other than the phenylosazone had been prepared, as, for example, the acetyl and benzoyl compounds. Was the evidence of the identity of revertose based solely on the physical constants and the osazone?

In reply, Dr. Croft Hill stated that revertose was obtained in white, crystalline, very hygroscopic crusts by dehydrating the vitreous mass in which it first separates from its alcoholic solution. It still contained a little ash, but the osazone was obtained quite pure.

Revertosazone is readily distinguished from Fischer's *iso*maltosazone by the fact that it is optically inactive, whereas Fisher's *iso*maltosazone was dextrorotatory.

The fermentation experiments with maltase-containing yeasts on the one hand, and with *S. Marxianus* on the other, were conducted on parallel lines, analyses being made at every step. The difference in the two cases could only be explained by the fact that in the former case a part of the synthetical product was fermented.

The view put forward by one school of chemists in Germany, that the action of ferments was not truly reversible, but that the substance synthesised is always different from the substance hydrolysed, is untenable, for in every case the synthesised substance can again be hydrolysed by the ferment which produces it.

He considered it likely that conditions of equilibrium may favour such a practical outcome, and the synthetical process in the organism may have such a relationship to the analytical process, but, theoretically, each component of the process is reversible in the strictest chemical sense.

°53. "*Discoloured Rain.*" By E. G. Clayton.

The rain which fell for some hours on Sunday, February 22nd, 1903, in all counties south of the Thames, and elsewhere, as at Clare in Suffolk, Oswestry in Salop, and on the Continent, as at Bochum in Westphalia, was turbid and discoloured, soiled window glass to an unusual extent, and left, on exposed surfaces, a greyish brown or terra-cotta-coloured deposit. The wind prevailing at the time was very high, and generally westerly or south-westerly. It has been suggested that the deposit was of volcanic origin, and probably due to the West Indian eruptions.

The following results were obtained with a specimen of the rain collected by Mr. R. Pound at Ashbury, near Shrivenham, Berkshire.

Chemical Examination.—After five days, the water remained opalescent, and yielded an extremely fine, light brownish red sediment:—

		Parts in 100,000.		Parts in 1,000,000.
(*a*).	Dissolved solids (dried at 150°)	25·1	Ammonia (free and saline)	0·95
	Dissolved solids (after ignition)	21·1	Ammonia (on boiling with alkaline permanganate) .	0·15
(*b*).	Suspended matter	23·6		
	Chlorine	2·0		

The residue (*a*), after evaporation, blackened on ignition with an odour of burning wood, and, on further heating, the carbon soon disappeared. The inorganic matter was mainly calcium carbonate; alkaline chlorides and iron compounds being also present.

The suspended matter, which contained a mere trace of carbonate, was almost insoluble in dilute acids, but decomposed on warming with moderately concentrated sulphuric acid; its chief components were silica (67·5 per cent), alumina and ferric oxide (14·1 per cent), and volatile matter (12·4 per cent). The separated silica was perfectly white, and the volatile matter principally of organic origin.

The great differences between this specimen and ordinary rain water, especially as regards the proportions of chlorine, dissolved solids, and suspended substance, are sufficiently obvious.

Biological Examination.—One c.c. of the water, by plate cultivation on nutrient gelatin at 20—22°, yielded, by the fourth day, 420 bacterial colonies. Of these, 19 were non-liquefying iridescent expansions of irregular outline, having the characters of *Bacillus fluorescens non-liquefaciens*; the rest, which were sharply outlined circular pearly dots, resembled *Bacillus liquefaciens*, and began to liquefy the gelatin on the third day. After incubation for twenty-four hours at 38°, 1 c.c. of the water showed, in five days, only 33 bacterial colonies (*Bacillus subtilis?*).

Microscopical Examination of the Sediment.—The particles, which range in size from 0·001 to 0·005 m.m., were yellow or brown, ressembling those of clay. This similarity was noticed by Prof. Bonney in a recently published letter describing some specimens of the deposit which he had received. In the sediment now under dis-

cussion, there were no vitreous, and very few angular, particles; between crossed Nicols prisms, the field was faintly illuminated. No pollen granules could be distinguished (although these appear to have been observed at Denchworth, Berkshire). The analysis, however, clearly indicates that some organic matter was present, both in solution and also in suspension in an exceedingly fine state of division.

The results show that this rain was charged with wind-borne dust, which in the specimen examined was a marly and ferruginous clay, mixed with organic refuse, perhaps of animal, as well as vegetable, origin; the calcareous matter had mainly dissolved in the water, which contained carbon dioxide, whilst the argillaceous and siliceous portions were carried in suspension. This composition is just such as might be expected in dust blown from the Jurassic and Cretaceous drift of Wessex roads and lanes. It is, therefore, not necessary to assume that the dust was conveyed either from remote regions or across the sea, and there are good grounds for supposing that, if a series of analyses had been made of the rain and sediment from different places, the figures would have reflected in some degree the local characteristics of the soils and subsoils of areas situated at a distance of a few miles, or even less, immediately to the west or south-west of those places. In a marly district, the ratio of calcareous matter to clay and silica would be high; where loam prevailed, fine siliceous sand would predominate; further west, felspar crystals and ferro-magnesian minerals would abound, possibly with less organic matter; from highly cultivated tracts, pollen granules might arise, and so on. Ashbury is situated partly on the Upper Greensand and partly on the chalk, and in the vicinity there are extensive areas of clay and chalk. An analysis by Mr. R. A. Earp (*Nature*, 1903, lxvii., 414) of matter deposited by the rain which fell on the same day at Buckfastleigh, Devon, showed that the sediment there contained less silica and more organic matter than the deposit examined by the author.

Discussion.

Dr. H. R. Mill said that he was investigating the fall of dust on February 22nd from a meteorological point of view in conjunction with Mr. Lempfert, of the Meteorological Office, and Mr. Clayton's theory of the local origin of the dust would be tested before long by the examination of fifty specimens obtained from rainfall observers and others in many parts of England and Wales, and some places abroad, this work having been undertaken by the Geological Survey. The magnitude of the dust-fall made it difficult to accept this hypotheses without very strong proof. In the south of England and in Wales, the dust, which was remarkably uniform in appearance, had fallen either dry or in rain over a space of 300 miles from west to east and 200 miles from south to north, whilst traces had occurred at intervals over the whole area of the British Isles from Scilly to Shetland. The fact that similar dust was observed on the same day over the greater part of the Channel Isles, Belgium, and Holland, and at many places in Germany, Switzerland, and Austria, as well as in the North Atlantic, whilst dust-storms prevailed off the coast of Africa, made a common origin seem very probable, and perhaps this was a case of far-travelled, wind-borne dust.

54. "*The Absorption Spectra of Nitric Acid in Various States of Concentration.*" By W. N. Hartley.

Photographs have been obtained of the spectra of nitric acid in eight different states of concentration, varying from 89·6 per cent of HNO_3 (sp. gr. 1·490 at 15°) to 20·31 per cent (sp. gr. 1·127 at 15°).

Acid of sp. gr. 1·490 transmits a very short spectrum, which is greatly lengthened by dilution. The acid of sp. gr. 1·432 (72·57 per cent) transmits a longer spectrum than the 20·31 per cent solution, but this is shortened on dilution; in like manner, weaker acids down to that of sp. gr. 1·127 behave in the same way, but here the dilute solution transmits a spectrum nearly as long as the strong acid. From this point onwards, an absorption band makes its appearance. If water acted simply as a diluent, dilution would cause an increase in the length of the transmitted spectra which would be proportional to the quantity of water added. There is evidently some chemical action between the water and the acid, but this action with acid of sp. gr. 1·490 is different from that with acid of sp. gr. 1·432 or any less concentrated acid. Hence it is probable that in strong nitric acid, the molecule is either polymerised to $n(HNO_3)$, or resolved into a compound of the nature of N_2O_5,H_2O. The acid of sp. gr. 1·490 might be represented either as a mixture, $N_2O_5,H_2O+H_3NO_4$, or as a compound, $H_3N_3O_9,H_2O$. The weaker solutions of the acid probably contain hydrates. Evidence is afforded that the strong acid contains two different substances, one of which acts on caustic lime whilst the other does not.

55. "*Salts of an Isomeric Mercaptoid Form of Thio-allophanic Acid, and a New Synthesis of Alkyl Imino-thiocarbamates.*" By A. E. Dixon.

By heating ethyl chlorocarbonate with phenylthiourea on the water-bath in presence of benzene, carbon dioxide was expelled and a yellow syrup formed, the latter being the hydrochloride of Bertram's (*Ber.*, 1892, xxv., 55) ethyl iminophenylthiocarbamate, $NPh:C(NH_2).SEt$ or $NHPh\cdot C(NH)\cdot SEt$:—

$$NHPh\cdot C(NH)\cdot SH + EtO\cdot COCl = CO_2 + NHPh\cdot C(NH)\cdot SEt,HCl.$$

With methyl chlorocarbonate, under like conditions, the hydrochloride of methyl iminophenylthiocarbamate was obtained.

p-Tolylthiourea and methyl chlorocarbonate yielded the *hydrochloride* of *methyl imino-p-tolylthiocarbamate*, $NH(C_7H_7)\cdot C(NH)\cdot SMe,HCl$, in long, white prisms melting at 154—155°; the corresponding *base* could only be obtained as an oil. From *o*-tolylthiourea, by heating with methyl chlorocarbonate, a syrupy hydrochloride was produced; the corresponding free base, liberated by the cautious addition of alkali, crystallised from light petroleum in white lozenges melting at 101—102°.

Methyl iminoallylthiocarbamate, $NH(C_3H_5)\cdot C(NH)\cdot SMe$, was not precipitated by alkali from the aqueous solution of its hydrochloride; the *picrate* formed yellow, hair-like needles melting at 149—150° (corr.).

Thiocarbanilide, when heated with ethyl chlorocarbonate, affords a carbethoxy-derivative melting at 95°, which is non-basic, and appears to have the constitution $NHPh\cdot CS\cdot NPh\cdot CO_2Et$ (Seidel, *Journ. Prakt. Chem.*, 1885, xxxii., 262); the *methyl* homologue crystallises from alcohol in white needles melting at 105°.

Experiments conducted in the cold led to results entirely different from those just mentioned; thus, methyl chlorocarbonate, when allowed to remain in contact with finely-powdered, monosubstituted thioureas, gradually reacted, without evolution of gas, to form additive products; these substances, which dissolved freely in water, yielding very acid solutions, proved to be hydrochlorides. By neutralising with alkali, or even by prolonged boiling of their aqueous solutions, the acid could be readily withdrawn, thereby leaving crystalline solids, sparingly soluble in water, and melting, with decomposition, at relatively high temperatures.

The following compounds of this class are described:—

Methyl phenylthio-ψ-allophanate,—

$$NHPh\cdot C(NH)\cdot S\cdot CO_2Me,$$

brilliant prisms, m. p. 166—167° (corr.); *methyl* p-*tolylthio-ψ-allophanate*, $NH(C_7H_7)\cdot C(NH)\cdot S\cdot CO_2Me$, flattened, white prisms, m. p. 175—176° (corr.); *methyl* o-*tolylthio-ψ-allophanate*, colourless prisms, m. p. 175—176° (corr.).

Thiourea itself also affords, with chlorocarbonates, two distinct classes of derivatives.

Ethyl thio-ψ-allophanate, $NH_2\cdot C(NH)\cdot S\cdot CO_2Et$, is

formed when thiourea and ethyl chlorocarbonate are very cautiously warmed in presence of benzene or, preferably, absolute alcohol, or by adding carbonyl chloride, in toluene, to thiourea suspended in absolute alcohol; its hydrochloride forms beautiful, transparent octahedra melting at 116—117° with effervescence, due to the escape of carbon dioxide; the fusion product, a viscid syrup which appears to be identical with that obtained by heating thiourea with the chlorocarbonate, is the *hydrochloride* of *ethyl iminothiocarbamate*, $NH_2{\cdot}C(NH){\cdot}SEt$.

Methyl thio-ψ-allophanate, like the ethyl homologue, is readily soluble in water; its hydrochloride forms a white, crystalline powder, which melts at 89—90° with effervescence, and is thus converted into *methyl iminothiocarbamate hydrochloride*, $NH_2{\cdot}C(NH){\cdot}SMe,HCl$; this product, when obtained by heating thiourea and methyl chlorocarbonate in presence of benzene, separates as an oil, which subsequently changes to a crystalline solid melting at 59—60°. Both this and the corresponding ethyl derivative give mercaptan with cold alkali hydroxides, and yellow precipitates with alkaline lead and silver salts; the thio-ψ-allophanic compounds, on the other hand, yield no mercaptan with alkali, and are simply desulphurised by treatment with the metallic salts.

56. "*Derivatives of* o-*Aminobenzophenone and* p-*Aminobenzophenone.*" By F. D. Chattaway.

Considerable quantities of *o*-aminobenzophenone and *p*-aminobenzophenone having been prepared in an investigation of the transformation of dibenzanilide into these substances (*Proc.*, xix., 57), a number of their nitrogen halogen derivatives have been studied. These are formed by the action of aqueous hypochlorous or hypobromous acid on the acylaminobenzophenones dissolved in alcohol, but in order to obtain products that can be crystallised it is necessary to work at a low temperature and to guard carefully against any liberation of free halogen. The nitrogen halogen derivative can be extracted with chloroform, and re-crystallised from light petroleum or a mixture of this and the preceding solvent.

Acetyl-o-chloroaminobenzophenone, $Ph{\cdot}CO{\cdot}C_6H_4{\cdot}NClAc$, colourless, flattened prisms with domed ends, m. p. 102°; *acetyl-o-bromoaminobenzophenone*, $Ph{\cdot}CO{\cdot}C_6H_4{\cdot}NBrAc$, short, transparent, yellow prisms, m. p. 121°; *propionyl-o-chloroaminobenzophenone*, $Ph{\cdot}CO{\cdot}C_6H_4{\cdot}NCl{\cdot}COEt$, clusters of colourless, flattened prisms, m. p. 107°; *propionyl-o-bromoaminobenzophenone*, clusters of yellow plates, m. p. 90°; *benzoyl-o-chloroaminobenzophenone*, $Ph{\cdot}CO{\cdot}C_6H_4{\cdot}NCl{\cdot}COPh$, colourless, rhombic plates, m. p. 98°.

Acetyl-p-chloroaminobenzophenone, groups of colourless, slender, flattened plates, m. p. 124°; *acetyl-p-bromoaminobenzophenone*, groups of pale yellow, six-sided plates, m. p. 151°; *propionyl-p-aminobenzophenone*, colourless, elongated plates, m. p. 139°; *propionyl-p-chloroaminobenzophenone*, colourless, flattened prisms, m. p. 129°; *propionyl-p-bromoaminobenzophenone*,—

$$Ph{\cdot}CO{\cdot}C_6H_4{\cdot}NBr{\cdot}COEt,$$

pale yellow plates, m. p. 123°; *benzoyl-p-chloroaminobenzophenone*, clusters of colourless plates, m. p. 107°; *benzoyl-p-bromoaminobenzophenone*, clusters of yellow, rhombic plates, m. p. 93°.

The transformation which occurs when these substituted nitrogen chlorides and bromides are heated above their melting-points is accompanied by considerable decomposition, and dark, impure products are obtained. When the compounds are dissolved in acetic acid and warmed, the halogen passes from the nitrogen into the ring in the usual manner.

57. "*Action of Caustic Alkalis on Cinnamic Acid Dibromide and its Esters.*" By J. J. Sudborough and K. J. Thompson.

Good yields of α-bromocinnamic and α-bromo*allo*cinnamic acids may be obtained under suitable conditions by the action of caustic alkalis on cinnamic acid dibromide and its esters. The relative amounts of the two acids produced depend mainly on the employment either of the acid dibromide or of an ester, and, to a less extent, on the alkali and the solvent; the yield of α-bromo-acid (m. p. 131°) is always greater when an ester is employed. In no case has it been found possible to obtain only the normal product, namely, α-bromo*allo*cinnamic acid. The two acids are readily separated by the aid of their barium salts.

A by-product often obtained is ω-bromocinnamene, CHPh:CHBr, and this appears to be a primary decomposition product of the acid dibromide, and is therefore not obtained indirectly from one or the other of the α-bromo-acids, as stated by Barish. The addition of bromine to ethyl cinnamate and the transformation of the *allo*-acid into the α-bromo-acid have also been studied.

58. "*The Composition of Caro's Acid.*" By T. S. Price.

Amstrong and Lowry (*Proc. Roy. Soc.*, 1902, lxx., 94) have shown that, in dilute solution, Caro's acid is to be represented either by the formula $H_2S_2O_4$, assuming that the acid is dibasic, or by H_2SO_5 if the compound is regarded as monobasic. Since this conclusion is opposed to the results formerly obtained by the author (*Ber.*, 1902, xxxv., 292), a new series of experiments on the increase of acidity has been undertaken, and the revised data now agree with the results of these investigators, although the method employed in the author's experiments was less accurate.

The increase in acidity was formerly estimated by means of barium hydroxide solution, but Caro's acid, when neutralised by this alkali, is decomposed, 1 mol. of $H_2S_2O_9$ giving rise to 2 mols. of H_2SO_4, so that the actual increase is twice the calculated quantity. If sodium hydroxide is employed, the acid is not decomposed, and the normal increase in acidity is indicated.

This difference in the behaviour of the two alkalis is also suggested by a determination of the ratio of iodine equivalent to increase in acidity, the mean values found being 4·74 and 2·75 for sodium hydroxide and barium hydroxide respectively. The deviation from the corresponding theoretical numbers (5·18 and 2·59) is probably due to experimental errors.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Ordinary Meeting, March 31st, 1903.

Mr. Charles Bailey, M Sc., F.L.S., President, in the Chair.

Mr. R. L. Taylor, F.C.S., read a paper entitled—I. "*On a Higher Oxide of Cobalt*; II. *A Method for the Volumetric Determination of Cobalt.*"

He stated that there appears to be a considerable number of higher oxides of cobalt—higher than the sesquioxide. The sesquioxide, indeed, is very seldom obtained by precipitation from solutions of cobalt. Mr. Taylor finds that the black oxide of cobalt, which is precipitated from an exactly neutral solution by calcium or barium carbonate in presence of bromine water, is fairly constant in composition, and may be represented as either Co_9O_{14} or Co_7O_{11}. Like the rest of the somewhat complicated oxides which have hitherto been described, it is probably a mixture or compound of the sesquioxide and the dioxide. As cobalt is completely precipitated in five to ten minutes by calcium or barium carbonate in presence of bromine water in a perfectly neutral solution, Mr. Taylor proposes to dissolve the precipitated oxide, after washing, in a mixture of hydrochloric acid and potassium iodide (Bunsen's method). Then, by determining the amount of iodine liberated, it is possible to find the amount of cobalt which was present. In calculating the result, the composition of the precipitated oxide is taken

as intermediate between the two given above. Before precipitation of the colbalt the solution must be free from iron, lead, and manganese. Nickel does not interfere. The volumetric process has been tested by Mr. J. H. Davidson, B.Sc. (Vict) in the assay of cobalt ores, with satisfactory results.

NOTICES OF BOOKS.

The Chemical Changes and Products Resulting from Fermentations. By R. H. Aders Plimmer, D.Sc.(Lond.). London, New York, and Bombay: Longmans, Green, and Co. 1903. Pp. 184.

In this volume the author deals seriatim with the chemical changes which are the result of the fermentation of the carbohydrates and the albumins. These changes are generally brought about by hydrolysis, but oxidation as well as reduction also takes place.

The carbohydrates are generally divided into four classes, viz., the polysaccharides, the trisaccharides or saccharotrioses, the disaccharides or saccharobioses, and the monosaccharides or monoses. These are each dealt with specially in the first six chapters.

Chapter XIII. is an interesting one; it is on the nitrification and denitrification taking place in the soil; it is known now that these processes of oxidation and reduction are the results of the action of several micro-organisms. Formerly it was thought that the change of ammonium salts into nitrates in the soil was a purely chemical reaction, but the results of the researches of several investigators, Frankland, Warington, and Winogradsky among others, showed that the action was a bacterial one, and took place in two stages. In the first stage the ammonium salts are converted into nitrites, in the second stage the nitrites are converted into nitrates. Other bacteria, again, have the property of liberating free nitrogen from these salts, and this is assimilated by another set of bacteria occurring in the roots of leguminoses, and converted into albuminous bodies. This short description may be taken as an indication of the general contents of this interesting book. Fermentation, changes in blood, in milk, in muscle, are all described, and the reactions made clear.

On page 141 the author sums up his principal deductions from the chemical changes occurring in fermentation as follows:—"1. That the active agent in all cases is a living organism. 2. That this organism sets up either by its own metabolism, or by bodies secreted by or excreted from it, changes in substances of different constitutions; *e.g.*, carbohydrates and albumins. 3. That these changes are principally hydrolytic, and that some are oxidative and a few reductive. 4. That the results of these changes are generally simplifications of the original body. 5. In certain cases synthesis occurs."

The book is well and carefully written, and contains much that is both useful to the specialist and interesting to the general reader.

There is a long bibliographical list of books and papers bearing on the subject, and two indices, one of authors' names, the other of subjects.

Elementare Voolesungen über Telegraphie und Telephonie. 3 Lieferung. ("Elementary Lectures on Telegraphy and Telephony," Part III.). By Dr. Richard Heilbrun. Berlin: Georg Siemens. 1902.

In the continuation of these elementary lectures on telegraphy and telephony the leading features of the previous volume are conspicuous. They bear the impress of the able and efficient teacher in the simplicity of the language employed, the fulness of explanation given, and, above all, in the way in which the difficulties, often only partly realised even by the students themselves, are forestalled. This volume contains the conclusion of the lecture on the chemical effects of currents, and a lengthy lecture on the production of currents, including the various modifications of cells and their arrangements in batteries, all very lucidly described, and illustrated by excellent explanatory diagrams.

Beiträge zur Chemischen Physiologie und Pathologie ("Contributions to Chemical Physiology and Pathology"). Edited by Franz Hofmeister. Band III. 11 Heft. Braunschweig: Friedrich Viewig und Sohn. 1903.

The most important paper in the February number of these *Beiträge* is one on "The Anaërobic Metabolism of the Higher Plants, and its Connection with Alcoholic Fermentation," by J. Stoklasa, Joh. Jelinek, and Eugen Vitek. This will be read with the greatest interest by all physiological chemists. The authors have examined the problems connected with the isolation of invertase, and believe that they have proved the presence of an enzyme in the juice of *Beta vulgaris*, which though possibly not identical with Buchner's zymase, at any rate has much in common with it. The paper describes in detail the authors' careful and painstaking researches, during the course of which important results have been obtained. Other articles in the number include a short paper on the composition of ovo-mucoid, by Leo Langstein, and another by A. Ostwald on the action of iodine on the protein substances.

Vorlesungen über Experimental Physik ("Lectures on Experimental Physics"). By August Kundt. Braunschweig: Friedrich Viewig und Sohn. 1903.

These lectures were delivered by the late Prof. Kundt in the years 1888-89, and have been prepared for publication by Dr. Karl Schiel. Though considerable advances have been made in the last fifteen years in the generally accepted methods of teaching an experimental science, it has not been thought advisable to make any additions to, or alterations in, these lectures lest their highly characteristic style should be thereby impaired. The text is prefaced by a short life of Kundt, and appreciation of his works by his brother-in-law, G. Schwalbe. The subjects of the lectures include the elementary principles of mechanics, heat, sound, electricity and magnetism, and optics, and the treatment throughout is such as to exclude almost entirely the use of even the most elementary mathematics, though in other respects it is very full, and likely to suggest to the teacher many useful ideas and methods in training the students' powers of induction. The book is not designed for use in the laboratory, and hence no practical details are included for performing the many experiments described. The pages devoted to sound exhibit most clearly the characteristics of the author, and will undoubtedly be found particularly attractive and stimulating. The illustrations and diagrams are copious throughout, and particularly clear.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
Series 3, Vol. xxvii., No. 20—21.

Electric Conductivity of the Oximidocyanacetic Ethers.—P. Th. Muller.—The author finds that it is possible to calculate the infinite molecular conductivity of the sodic salts of these bodies by means of the Ostwald-Bredig law, which characterises them as distinctly monobasic acids; the nitroso-ethers behave just like ordinary carboxylised acids.

The Soda Salts of the Isonitrated Derivatives; a New Method for Diagnosing the Pseudo-acids.—P. Th. Muller.—Already noticed.

The Precipitation of Cupric Chloride and Bromide by Sulphuric Acid.—Georges Viard.—*Cupric Chloride.*—Sulphuric acid added in large excess to the solution drives off bubbles of hydrochloric acid, while the mixture becomes very hot, but the amount of chloride decomposed is very slight, and nearly all the dissolved salt is precipitated in the form of brownish-yellow anhydrous chloride. When the sulphuric acid is not in sufficient excess, the green hydrated chloride, $CuCl_2+2H_2O$, is precipitated. More than 68·4 per cent of its weight of sulphuric acid must be added for the anhydrous chloride to be formed. This anhydrous chloride appears as very small yellow crystals under the microscope; by allowing the green solution of $CuCl_2$ in H_2SO_4 to cool slowly, much more voluminous arborescent crystals are deposited. *Cupric Bromide.*—An excess of sulphuric acid precipitates this salt from its solution, but the precipitate always consists of the black anhydrous bromide. The reaction is much more sensitive than with the chloride, a solution of 1/200th $CuBr_2$ with an excess of sulphuric acid gave an abundant black precipitate. The difference of solubility of the chloride and the bromide in sulphuric acid furnishes a ready means for distinguishing between these two salts. A mixture of 1 volume of sulphate of copper at 1/10th with 10 volumes of H_2SO_4 is prepared in advance. By adding to this mixture a few drops of the salt to be tested a precipitate is formed; if yellow it is a chloride, if black it is a bromide. In this manner a solution of KCl at 1/100th, or of KBr at 1/200th can be recognised.

The Precipitation of the Chlorides and Bromides of Cadmium, Mercury, and Tin by Sulphuric Acid.—G. Viard.—Already noticed.

Improvements in the Use of Marsh's Apparatus.—A. Gautier.—Requires the accompanying drawing.

Condensation of Ethylic Alcohol with Œnanthylic Alcohol; Synthesis of Normal Nonylic Alcohol.—Marcel Guerbet.—If œnanthylic alcohol is heated with sodium ethylate, normal nonylic alcohol is produced according to the equation $C_7H_{16}O+C_2H_5ONa=C_9H_{20}O+NaOH$. The synthesis is effected best by heating the mixture obtained by dissolving 1·20 grms. of sodium in 8 grms. of œnanthylic alcohol, and 10 grms. of ethylic alcohol, to 230° in sealed tubes. Ethylene, hydrogen, acetic and œnanthylic acids, and alcohols, which can be separated by fractional distillation, are formed. The fraction coming over at 190—215° is rectified, and, finally, 8 grms. of an alcohol boiling at 212—214° is separated; this has the composition of normal nonylic alcohol, $C_9H_{20}O$.

Condensation of Œnanthylic Alcohol with Propylic Alcohol; Synthesis of Methyl-8-nonylol-9.—Marcel Guerbet.—The operation, conducted as in the last note, and using 100 grms. of œnanthylic alcohol and 250 grms. of propylic alcohol, gives 18 grms. of an alcohol boiling at 221—223°, having the formula $C_{10}H_{22}O$. This decylic acid is an oily colourless liquid with an odour of tallow, boiling at 261—265°; its constitution is found to be $CH_3.(CH_2)_6.CH(CH_3).CO_2H$, and that of the corresponding alcohol is $CH_3.(CH_2)_6.CH(CH_3).CH_2.OH$.

Action of the Chlorides of the Fatty Acids on the Soda Derivatives of the Acetylacetic Ethers.—L. Bouveault and A. Bongert.—The authors describe the preparation of sodacetylate, the action of the acid chloride on the soda derivative, the separation of the two isomerous acylised derivatives, and the acid chloride derivatives of high and low molecular weights.

The O-acylised Derivatives of the Acetylacetic Ethers and their Decomposition.—L. Bouveault and A. Bongert.—These bodies are true ether salts of the enolic compound isomerous with acetylacetic ether; that is to say, β-oxycrotonic ether. A number of these derivatives are described. Water is without action on the *o*-acylised derivative, even in sealed tubes at 140—150°. Aqueous ammonia decomposes the *o*-butyrylacetylacetate of methyl into butyrate of ammonium and acetylacetate of methyl, but dry ammonia gas gives butyramide and β-amidocrotonate of methyl, by reason of its subsequent reaction on the regenerated acetylacetate of methyl.

The Formation of Trioxymethylene by the Direct Oxidation of the Aromatic Compounds of the Metho-ethylenic Chain.—M. Tiffeneau.—Under the influence of slow oxidation in contact with the air, the aromatic compounds of the metho-ethenylic chain, $R-C\lessgtr^{CH_2}_{CH_3}$, give rise to formic aldehyde, which is deposited in the form of trioxymethylene on the sides of the flask in which it is contained. It is isolated by filtration, washing with ether and desiccation, and commences to sublime slowly at 100°; it fuses at 160°. It is insoluble in the ordinary solvents, but completely soluble in ammonia, with the formation of hexamethylene-tetramine, which can be isolated by evaporating the ammoniacal solution *in vacuo*.

Presence in the White of Egg of a Fibrinogenous Substance which is Transformed "in vitro" into Semiorganised Membranules.—A. Gautier.—There exists in egg albumin from hen's eggs (and probably in those of other birds) an albumenoid substance to which the name *ovofibrinogen* is given; it is analogous to the fibrinogen of the blood or to the myosimogen of living muscle; 1·5 per cent of ovofibrinogen is found in dry egg albumin. Solution in water, heat, or alkalinity, conditions which assist the action of cellular animal ferments, favour also the transformation of ovofibrinogen into ovofibrin.

MISCELLANEOUS.

Action of Baryta and of Sodium on the Aldehydes.—Anton Lederer.—Concentrated solutions of baryta react with acetaldehyde and crotonic aldehyde, resinifying them. Isobutylic aldehyde, heated with baryta water in a sealed tube to 150°, gives a mixture of alcohol and isobutyric acid. That is to say, it constitutes an exception to the rule previously announced (*Bull. Soc. Chim.*, vol. xxviii., p. 477), as the neighbouring carbon of the CHO, in this case, still contains an atom of hydrogen. Under the same conditions isovalerianic aldehyde simply undergoes condensation, giving α-isopropyl-β-isobutylacrolein, already described by Kohn (*Bull. Soc. Chim.*, vol. xvi., p. 1630). Sodium reacts vigorously on isobutylaldehyde; during the reaction a little isobutylic alcohol is formed, as well as isobutyrate of octylglycol. This latter is characterised by its saponification with potash alcohol, which separates it into Fosser's octylglycol, fusible at 51—52°, and isobutyric acid. It appears that the sodium only reacts through the soda formed by the small amount of moisture present; in fact, powdered caustic soda gives the same results. In the same manner, with isovalerianic aldehyde we obtain the corresponding valerianate of glycol.—*Mon. f. Ch.*, vol. xxii., p. 536.

MEETINGS FOR THE WEEK.

Monday, 27th.—Society of Arts, 8. (Cantor Lectures). "Mechanical Road Carriages," by W. Worby Beaumont, Mem.Inst.C.E.

Tuesday, 28th.—Royal Institution, 5. "The Blood and some of its Problems," by Prof Allan Macfadyen, M.D., &c.

—— Society of Arts, 7.30. (Applied Art Section). Visit to the Whitefriars Glass Works. "Modern Table Glass," by Harry Powell. (Special Tickets required).

Wednesday, 29th.—Society of Arts, 8. "Automatic Wagon Couplings on British Railways," by T. A. Brockelbank.

Thursday, 30th.—Royal Institution, 5. "Hydrogen—Gaseous, Liquid, and Solid," by Prof. Dewar, F.R.S., &c.

Friday, May 1st.—Royal Institution, 9. "Recent Advances in Stereo-chemistry," by Prof. W. J. Pope, F.R.S.

—— Royal Institution, 5. Annual Meeting.

Saturday, 2nd.—Royal Institution, 3. "The Early Art of Siena," by Prof. Langton Douglas, M.A.

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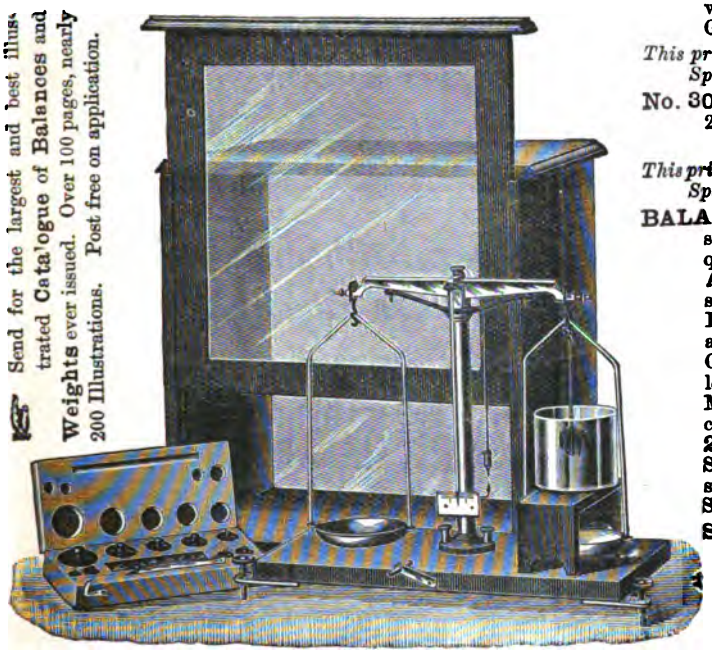

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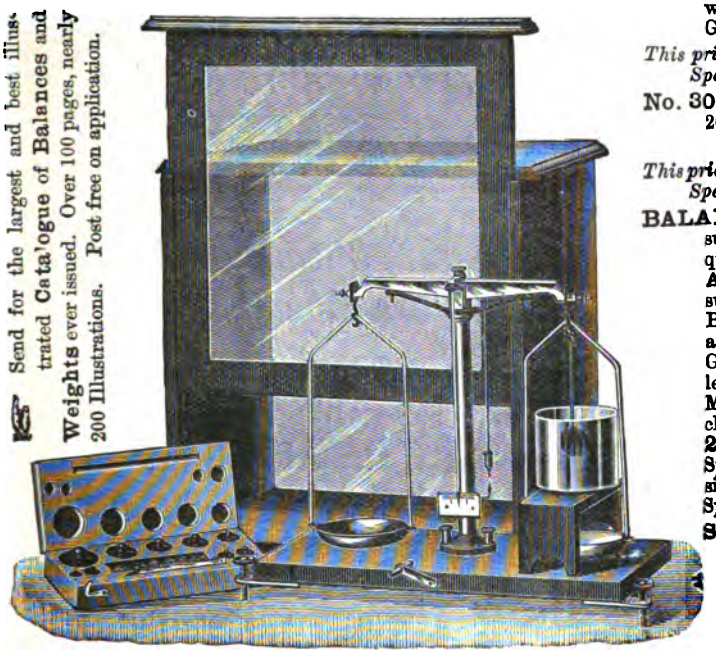

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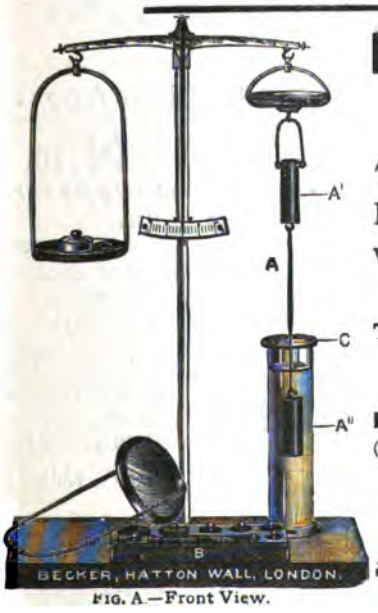

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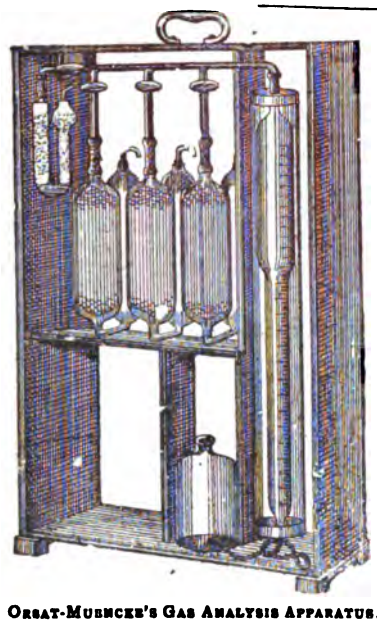

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CHEMICAL NEWS

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JOURNAL OF PHYSICAL SCIENCE

Edited by Sir Wm Crookes, F.R.S.] (WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE") [Established Fifty-eight Years.

Published Weekly. Annual Subscription, free by post, £1. Entered at the New York Post Office as Second Class Mail matter.

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Formerly Assistant Lecturer in Chemistry at the Yorkshire College, Leeds, and Lecturer in Chemistry at the Hull Technical School.

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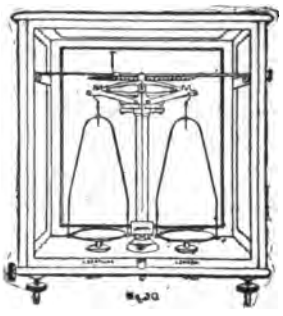

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THE CHEMICAL NEWS.

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A SIMPLE INSTRUMENT FOR MECHANICALLY CALCULATING THE WEIGHT OF VITRIOL IN CHAMBERS.

By C. DAVIDSON.

THIS instrument is very simple, both as regards materials and construction, and may easily be put together in a few hours by anyone possessed of a little skill in draughtsmanship; although, like most mechanical calculators, it is rather difficult to describe in words. The only mathematical principle involved is that of the proportionality of the sides about the equal angles in similar triangles—which is understood by everybody.

According to the usual formula, the weight in tons of the actual "oil of vitriol" in a chamber is given by the equation—

$$W = \frac{lbd}{12} \cdot \frac{62{\cdot}5}{2240} \cdot \frac{S\,P}{100}.$$

Where l is the length of the chamber in feet; b, its breadth, also in feet; d, the depth of acid in inches; S, the specific gravity of the acid; and P the percentage of oil of vitriol it contains.

For convenience of calculation, the right-hand member in usually written in the form—

$$d\left(\frac{62{\cdot}5\,lb}{12 \times 2240}\right)\frac{S\,P}{100}.$$

The value of the part within brackets is then calculated, once for all, for each chamber in the works, the series of values for the various chambers is tabulated, and a similar table of values of S P/100 from 70° Tw. to about 140° Tw. is also made out. The calculation of the stock of vitriol in a chamber is then reduced to a multiplication of three numbers.

For this operation a slide-rule with two slides would serve very well; and indeed if, instead of being marked as usual with scales of numbers, the graduations on the rule were made to correspond with the values of the above-mentioned expressions, and were marked accordingly, it would be difficult to imagine anything more convenient in the actual working. Such a slide-rule, however, would be rather expensive, and its construction is certainly beyond the skill of most men. The use of an ordinary slide rule in conjunction with tables of reference is much less satisfactory than the instrument to be described.

Notice first that if from the expression for W the factor S P/100 is left out, the result is the *weight in tons of a volume of water equal to that of the acid in the chamber.* This weight we shall call w, the weight of the acid itself being W. Our first proceeding, then, is to find w.

For simplicity, consider a single chamber, and let the value of $\frac{62{\cdot}5\,lb}{12 \times 2240}$ for such chamber be C_1; then we have $w = dC_1$, which is the same as $\frac{w}{C_1} = \frac{d}{1}$.

Consider Figure 1. The angles, O M P, O A B, are right; it follows that $\frac{MP}{OM} = \frac{AB}{OA}$. If, then, O B be a thread fixed at O, but otherwise movable in the plane of the paper, and if A B be a scale of equal parts representing depths of acid, then on moving the thread O B so as to intersect A B at any particular graduation, the length cut off on M P will give, when measured according to the proper scale, the value of the weight w.

To pass from this to the actual weight of oil of vitriol in the chamber requires only a second application of the same principle.

$W = w \cdot \frac{S\,P}{100}$; or, putting $\frac{S\,P}{100} = C_2$, $W = wC_2$. This may again be written in the form $\frac{W}{C_2} = \frac{w}{1}$. So that, by means of an additional scale graduated for the values of C_2, the weight W may be obtained.

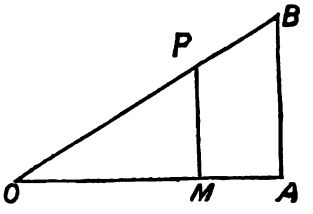

FIG. 1.

The details of construction and the fixing of proper values for the units will best be understood by considering a particular case. In a set of five chambers, the values of the expression $\frac{62{\cdot}5\,lb}{12 \times 2240}$ were as under:—

TABLE I.

No. 1	5·85
„ 2	7·25
„ 3	6·04
„ 4	6·04
„ 5	4·07

The values of the expression S P/100 for acids of 70—145° Twaddel are given in Table II., which is calculated from that in Lunge and Hurter's "Alkali Makers' Pocket-book."

TABLE II.

70°	0·606	108°	0·976	146°	1·368
71	0·615	109	0·987	147	1·378
72	0·624	110	0·997	148	1·388
73	0·634	111	1·007	149	1·398
74	0·644	112	1·017	150	1·408
75	0·653	113	1·027	151	1·418
76	0·663	114	1·038	152	1·428
77	0·672	115	1·048	153	1·438
78	0·682	116	1·058	154	1·448
79	0·692	117	1·069	155	1·458
80	0·701	118	1·079	156	1·468
81	0·711	119	1·089	157	1·478
82	0·721	120	1·100	158	1·488
83	0·731	121	1·110	159	1·498
84	0·741	122	1·120	160	1·508
85	0·751	123	1·131	161	1·518
86	0·760	124	1·142	162	1·528
87	0·770	125	1·152	163	1·538
88	0·780	126	1·163	164	1·548
89	0·790	127	1·173	165	1·558
90	0·799	128	1·183	166	1·568
91	0·809	129	1·194	167	1·578
92	0·819	130	1·205	168	1·588
93	0·829	131	1·215	169	1·598
94	0·839	132	1·225	170	1·608
95	0·849	133	1·235	171	1·618
96	0·858	134	1·246	172	1·628
97	0·868	135	1·256	173	1·638
98	0·878	136	1·267	174	1·648
99	0·887	137	1·278	175	1·658
100	0·897	138	1·289	176	1·668
101	0·907	139	1·300	177	1·678
102	0·917	140	1·312	178	1·688
103	0·926	141	1·323	179	1·698
104	0·936	142	1·334	180	1·708
105	0·946	143	1·345	181	1·718
106	0·956	144	1·357	182	1·728
107	0·966	145	1·368	183	1·738

To construct the instrument, paste a sheet of damped paper (34 inches by 24 inches, or thereabouts) on a good drawing-board, well secured against warping, and having one long edge accurately straight.

When the paper has become thoroughly dry, draw a line, O A, about 3 inches from the straight edge of the board, and parallel to it. Take O about 4 inches from the left-hand side, and make O A about 20 inches long. At A draw A B, the line of "dips," perpendicular to the edge of the board, and about 20 inches long (Fig. 2). In the case

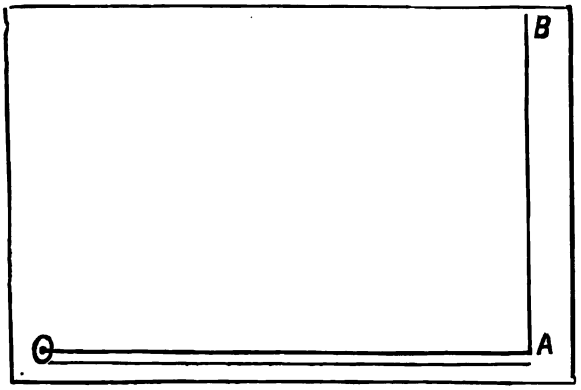

FIG. 2.

of the chambers mentioned above, the maximum depth of acid allowable is 25 inches; A B is therefore divided into 25 equal parts, and these are numbered 1 to 25, starting from A as zero. Each part is then subdivided into ten equal parts, and the scale is inked in.

tonnage of water per inch in each chamber—as given for the present case in Table I.—are laid down on a line drawn a quarter of an inch below O A and parallel to it, as shown. A separate line of this sort is graduated thus for each set of chambers, and the name or number of each chamber set at its own mark.

The values in Table II., being common to all the chambers, are laid down on O A itself, with the aid of the provisional scale already made. In order, however, to have the unit of the Twaddel scale of the most convenient size for working with, the values in Table II. are multiplied by 5, and the lengths on the scale corresponding to the products are marked off on O A. (The original scale may with advantage be inked in lightly on the under-side of O A; the Twaddel graduations being on the upper side. If this is done, any new chamber which may at a future time be added to the plant can have its graduation set alongside the others at once). These graduations are marked with the number of degrees Twaddel to which they correspond, and the scale is inked in.

Examination of Table II. will show that for acid at 110·3° Tw., SP/100 = 1.

At this point on the Twaddel scale on O A, erect another line perpendicular to the edge of the board. This is to carry a scale of equal parts, the unit for which we now proceed to find. Suppose we had 13·8 inches of *water* in chamber No. 2 above; this would weigh very nearly 100 tons. Join O to the 13·8 inch mark on A B, and from the mark for chamber No. 2 draw a line, perpendicular to O A, cutting the line last drawn. *The length of the vertical line intercepted between O A and the slanting line represents 100 tons.* Divide this line into ten equal parts, and extend the line to the top of the paper, continuing the graduations. Bevel the left-hand side of the T-square (the side which has been used for ruling these lines) till it is fairly thin at the edge, place it along this scale (keeping the stock against the edge of the board), and copy the scale on to

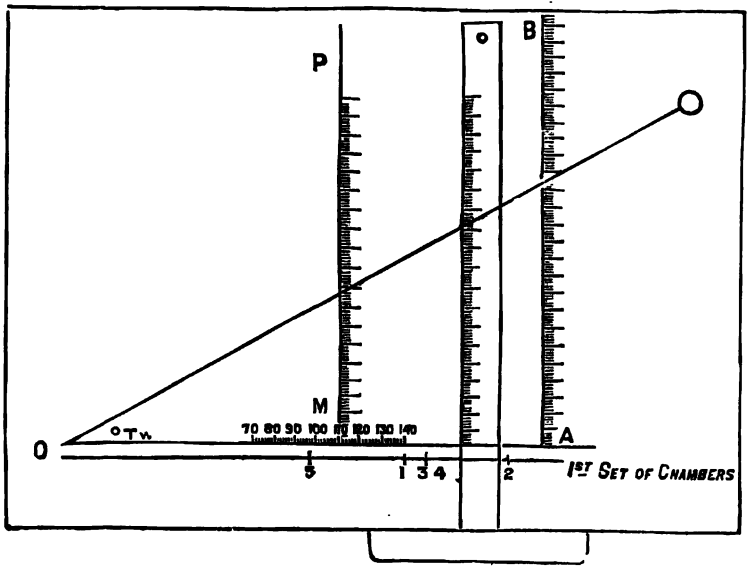

FIG. 3.

The values of the other two factors in the expression for W are laid off on lines parallel to O A. First of all, O A is divided into fifteen equal parts, and provisionally numbered, starting from O as zero, so that *two*-fifteenths of the total length is the unit; the figure at A being therefore 7·5. A O is then produced to unit length beyond O, and this last unit is divided into one hundred equal parts. By means of the scale so got, the values representing the

the T-square. Mark the graduations 0, 10, 20, &c., beginning at O A. Sub-divide each graduation into ten parts. Now slide the square along to the line drawn from the 110·3° Tw. mark, and copy the scale on to that line.

Fix one end of a strong thin silk thread at O, by looping it round a drawing-pin, and pass the other end of the thread (which is long enough to reach to the mark 25 on A B) up through a small hole in a thick circular piece of

lead heavy enough to keep the thread taut when placed so at any mark on A B. Fix the thread to the lead, and the instrument is complete, having the appearance shown in Fig. 3.

As an example of the working, let us suppose that we have 16·3 inches of acid at 126° Tw. in No. 1 chamber above. To find what this amounts to in tons of actual oil of vitriol, we set the thread to 16·3 on the line of "dips," slide the square along to the mark for No. 1 chamber, and read where the thread crosses the scale on the square; it will read 95·4. The thread is now moved to 95·4 on the scale M P, and the square slid along to 126° Tw. The reading at the point where the thread crosses the square now gives the weight of oil of vitriol in tons (110·9 tons).

It takes the most of an afternoon to graduate the instrument, but the saving of labour effected by it is considerable. Stocks may be calculated by it to within one-fifth of a ton more quickly (and *very* much more comfortably) than by means of logarithms; and the apparatus possesses the further advantage of requiring no reference whatever to tables of any kind. All the data required are on the instrument itself.

The author knows of works at which the oil of vitriol contents of a set of chambers are carefully calculated out to the nearest quarter of a hundredweight; that is so much energy wasted. The variation in strength of acid in a chamber from point to point is such that one must be satisfied with much less imposing figures.

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THE STRUCTURE OF SPECTRA.*

By Prof. CH. FABRY.

ALL those who have worked with the spectroscope, no matter how little, have had the opportunity of observing the magnificent spectacle offered by the spectrum of certain metals, such as that of iron, for example. But, to the feeling of admiration produced by the richness of the colours, the number and variety of aspect of the groups of lines, there is soon added, in the case of the attentive observer, a feeling of astonishment and uneasiness; all these brilliant lines, though emitted by the same vapour, seem to be thrown, haphazard, in all parts of the spectrum, as though by some capricious will without any systematic arrangement.

In other less complicated spectra, the eye seems to perceive some sort of regularity; but this appearance of orderly arrangement nearly always disappears when we endeavour to translate it into numerical relationships.

These lines of the same spectrum, so different in appearance and so irregularly distributed, have, however, a common origin, and it is difficult to admit that this progenitor, so to speak, does not show itself by some numerical relationship between their wave-lengths, or, in other words, between their positions in the spectrum. Such relationships have been searched for from the earliest days of spectroscopy. Though the first observations go back more than thirty years, it is only during the last fifteen years that this study has given rise to a slightly more extended collection and compilation of results, and there remains much more to be done before the observations are complete.

In the case of some spectra (those of the alkaline metals, for example), all the lines have been classified in a regular manner; the metals of the same family have analogous spectra, which are modified in a progressive manner as their atomic weights increase. With other metals, one part only of the lines shows any regular arrangement, and the others retain their arbitrary positions. Certain very complicated spectra, again, seem to escape all law.

* *Revue Générale des Sciences*, Year XIV., No. 5, March 15, 1903.

But in spite of all this, the results obtained up to the present form a very important collection, and it is these results that I propose now to examine.

I. *The Numerical Data.*

Each line in a spectrum shows the presence of a certain kind of monochromatic light in the radiation under examinination, or, in other words, a certain vibration of known period or wave-length. A line thus should be defined, not by a vague indication of colour nor by an arbitrary number on the scale of the spectroscope, but by the only element that can define it independently of all convention, the period of its vibratory movement, the number of vibrations taking place per second. According to an expression borrowed from the language of electricians, this number may be called the frequency of the vibratory movement under consideration. We know that in optics these numbers of vibrations are shown by millions of millions per second; they cannot be counted but only calculated, starting from the speed of propagation, V, which is very great, and the wave-length, λ, which is very small; the frequency, N, is then given by the equation $N = \frac{V}{\lambda}$, and the period by $T = \frac{\lambda}{V}$.

The speed, which is very difficult to measure, is not known closer than to a thousandth, but it is rigorously the same for all radiations, at least it is so *in vacuo*. On the other hand, the wave-lengths can be measured with extreme accuracy. As λ is simply proportional to T (V being constant), it is more simple not to bring the uncertainty of V into the numerical data of spectroscopy, and to define each radiation by its wave-length. These wave-lengths being very small, we measure them with a unit of the same order. We shall employ the thousandth of a micron, or the millionth of a millimetre (abbreviated, $\mu\mu$).*

The periods are directly proportional to the wave-lengths, and the frequencies are inversely proportional to them. We can take as a measure of the frequency the number of wave-lengths in a given distance, a tenth of a millimetre, for instance. In this manner we can express the number of vibrations occurring in a time which is perfectly determined, but imperfectly known, which gives the speed of light for a tenth of a millimetre as $\frac{1}{3} \times 10^{-12}$ second.

In short, the numerical data of spectroscopy consists of wave-lengths of the rays which compose the different spectra. The determination of these measurements has become comparatively easy, thanks to our knowledge of a large number of *datum* points in the spectrum. If they are sufficiently numerous, and if their wave-lengths are known exactly, it becomes an easy matter to determine the wave length of any given line by interpolation between two datum points which flank it, and this can be done, no matter what kind of spectroscopic apparatus is used. It must be borne in mind, however, that all errors in the datum points are repeated in the measurements deduced from them. The establishment of these fixed points has been a very laborious undertaking, and the names of Angström and Rowland stand out distinctly in connection therewith. All the modern numerical data are reduced to the figures of this latter worker; there are certainly numbers of small systematic errors, as has been pointed out recently by M. Perot and myself; but these errors are only in millionths, at least in the visible spectrum. We

* No international agreement has been come to yet on the choice of a unit for the measurement of wave-lengths. Most spectroscopists use the ten-thousandth of a micron (Angström's unit). That is not a matter of very great importance, since it only requires the moving of the decimal point. The use of $\mu\mu$ has this advantage, that the whole numbers of the usual wave-lengths are numbers of three figures, which are more easy to remember and repeat than those of four figures. For spectroscopic requirements, we should always give wave-lengths *in vacuo*, as they alone are exactly proportional to the periods of vibration. Experiment gives directly wave-lengths in the air; reduction to *vacuo* requires only a small correction, of which the calculation is easy with the help of the index of air.

have drawn up a table by which they can be corrected, but these corrections will be, as a rule, useless, as spectroscopic measurements can rarely attain this degree of precision. Thus, we may state, that for the usual kind of spectroscopic measurements Rowland's datum points are sufficient, but we can, if necessary, correct the figures obtained by their means.

When we reflect that the lines of certain spectra are to be counted by thousands, we get an idea of the enormous amount of work necessary to establish the numerical data of spectroscopy, and there is no need for astonishment that this work is not yet completed, in spite of prolonged researches, among which may be mentioned those of Kayser and Runge. The work is still increased by the fact that many substances give several spectra, according to the manner in which their vapour has been rendered luminous. The extreme sensitiveness of spectroscopic reactions further complicates the problem; if a trace of impurity is present in the body under examination, lines will be attributed to this substance which do not belong to it. Extremely great care and attention is necessary to prevent errors of this kind. Finally, for each line it is necessary to have a series of observations as to its properties, besides its wave-length; such as its width, brightness, appearance under varying circumstances of production, the manner in which it behaves under the influence of a magnetic field, or under the influence of increasing pressure of the surrounding medium, &c.

The compilation of these facts appears to be at first sight a useless and ungrateful task; but what follows will show that this is not the case at all, and that, as often happens, simple but important laws are found from accumulations of figures which have been collected simply through a love of exactitude.

II. *Doublets and Triplets at Constant Intervals.*

A comparison between the phenomenon of the emission of light and that of the production of sound occurs naturally to the mind, although the analogy is perhaps very far-fetched. But, admitting this comparison as legitimate, there is nothing any more surprising to see a gas emit several different luminous vibrations at one time than to hear a vibrating cord give at the same time its fundamental note and its different harmonics; the movement of the cord is a fairly complex periodic movement, which may be regarded as the superposition of a certain number of sinusoïdal movements, each of which corresponds in acoustics to a simple sound and in optics to a monochromatic light, and, consequently, to a definite spectral line. Now, in most of our musical instruments the different sounds emitted simultaneously obey the law of harmonics; their frequencies are as successive whole numbers. Depending on a mistaken analogy, we looked for analogous relations between the numbers of the vibrations of the movements emitted by a given luminous gas. We thought we had found some, generally only roughly approximate.

Recent researches have shown that these were only accidental. Certain spectra have such a large number of lines that we can find, with patience, all the numerical laws we wish to, always provided that the law sought for is only to apply to a small number of lines, and that we are contented with a slight degree of approximation. But the analogy upon which this preconceived idea was based was purely imaginary; even in acoustics movements which obey the simple law of harmonics are of rare exception; the limited powers of our ear have obliged us to choose our musical instruments in this exceptional category; we see no reason why the vibratory systems which emit light should belong to this category. Of the constitution of these systems we know nothing *à priori*. Only the study of facts undertaken without any preconceived ideas can teach us anything about the laws which connect the radiations given off.

The first well-founded fact was shown by M. Mascart in 1863; certain groups of lines of characteristic appearance are found repeated several times in the spectrum of the same metal. For example, magnesium gives a beautiful group of three fairly closely placed green lines, of which the wave-lengths are 518·38, 517·29, and 516·75. This triplet occurs several times with identical aspects in different parts of the spectrum of magnesium. M. Mascart found it three times in the ultra-violet, and now we know of fourteen examples, one in the infra-red, one in the visible spectrum, and twelve in the ultra-violet. Sodium gives a yellow doublet, known universally as the D line (lines D_1 and D_2 in the solar spectrum). Similar doublets occur twelve times in the sodium spectrum.

Although here we are dealing only with qualitative relationships, there can be no question of groupings due to chance; the probability of accidental triple groupings, like those in magnesium, is practically non-existent.

If we place these groups on a scale of wave-lengths (such as the spectra given by a train of prisms), we find that they are not all of the same dimensions; they become narrower as we advance towards the ultra violet. A simple change in the method of representing the spectrum suffices to show the existence of a numerical law. Instead of representing each line by its wave-length, let us represent it by its frequency, and let us draw the spectrum according to these new numerical data. This change has the effect of expanding to some extent the region of short wave-lengths; that is to say, that portion where the groups were the narrowest. All the groups of the same metal (Mg or Na) become identical, and absolutely superposable. These groups, which are easily seen in the spectra of Mg and of Na because they are very narrow, do not become confused, but are seen as distinct elements. The same is no longer the case when the groups are sufficiently wide to become entangled or confused one with the other. The numerical law once found in two particular cases, it becomes possible to look for analogous groupings in the spectra of other metals. Let us represent each line by its frequency, and on the spectrum thus drawn (or better still, on the numerical data themselves), we look for groups with the same dimensions repeating themselves several times. Such groups have been found by Rydberg, then by Kayser and Runge, in the spectra of a large number of metals.

The alkaline metals give, like sodium, spectra composed of doublets; the same is the case with copper and silver, metals which are placed next to the alkaline ones in L. Meyer's classified list.

The divalent metals (Mg, Ca, Sr, Zn, Cd, Hg) give triplets; the same is the case with the metalloids O, S, and Se. All these triplets are not formed of equidistant lines; going from the red towards the violet, the first interval we meet with is always narrower than the second. In several of these bodies the triplets are so wide and so confused that simple observations, without precise numerical data, would not enable us to recognise them (such is the case with the mercury spectrum).

Here is, therefore, an extremely simple primary law; to which we may perhaps with justice give the name of Rydberg's law:—In the spectra of a large number of bodies exist groups (doublets or triplets), which occur several times over; the interval which separates the lines (on the scale of frequencies) is the same for all the groups.

Further, this is not a law, more or less roughly approached; but the constancy of the intervals when we pass from one group to another, is verified with a precision equal to that of the measurements.

For certain metals the groups thus put in evidence offer a number of curious characteristics to which we shall return later on.

With bodies that give doublets we shall have to determine a fundamental constant, viz., the constant interval between the two lines of the doublet. We shall have two constants for substances with triplets; the interval from the first to the second, and that of the second to the third. It is interesting to compare together the constants of bodies of the same family. As the atomic weights become

greater the constants increase; that is to say, the groups become wider. For the alkaline metals the width of the doublets (expressed, of course, by difference of frequencies) varies with the squares of the atomic weights; this is shown in the following table:—

Metal.	Atomic weight. P.	Width between doublets. v.	$\frac{v}{P_2} \times 10^4$.
Li*	7	—	—
Na..	23	0·17	3·25
K	39	0·57	3·81
Rb..	85	2·34	3·22
Cs..	133	5·45	3·09

Although the numerical law may not be as simple in other families, the sense of the variation of the width of the groups is always the same.

Let us show, finally, that in the case of the alkaline metals, besides these doublets with constant intervals, there exist others which also form a natural family, and which are closer and closer together as we advance towards the smaller wave-lengths. They will be dealt with in the next section; they form the principal series of the spectra of these metals.

(To be continued).

ON THE

ACTION OF HYDROGEN MONOSULPHIDE ON TELLUROUS AND TELLURIC SOLUTIONS, WITH SOME NOTES ON THE SULPHIDES OF TELLURIUM.

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In the course of an enquiry into the various precipitation processes which have been devised for estimating tellurium, in which I have been engaged for some time past, and which has furnished the subject-matter of several communications to the CHEMICAL NEWS, I found occasion to further investigate chiefly from an analytical standpoint the action of H_2S on solutions of tellurium—tellurous and telluric—under varying conditions, and also to examine the precipitates thereby formed, with the object of assisting to clear away some of the doubt still apparently existing with regard to their exact character. The results of this work, being somewhat difficult of incorporation in either of my previous contributions, I have considered sufficiently interesting to be embodied in a separate communication.

Becker (*Liebig's Ann. Ch.*, xxx., 257—268), and, later, Brauner (*Journ. Chem. Soc.*, lv., 382—411), have shown that the statement originally made by Berzelius (*Pogg. Ann.*, viii., 411), and still to be met with in most of our text-books, that the precipitates obtained by the action of H_2S on solutions of compounds of TeO_2 and TeO_3 respectively are the sulphides corresponding to these oxides needs some qualification. This is made even more evident by the results of my own experiments.

(a). *Action of* H_2S *on Tellurous Solutions.*

The reddish brown precipitate which is at first formed when H_2S acts upon an acid tellurous solution quickly darkens, and, by the time the precipitant is present in excess in the liquid, becomes black and loses its flocculency. The brown precipitate is undoubtedly TeS_2, which, however, being very unstable, immediately dissociates, resolving itself almost entirely into a mixture of tellurium and sulphur, from which the latter element can be easily extracted by CS_2, with the exception of a small percentage which resists the action of the solvent and remains behind seemingly in combination with tellurium. It is stated by Becker that the proportions in which the elements occur in the precipitate are always "approximately" those required for TeS_2.

The H_2S precipitate when first formed readily dissolves in ammonium sulphide, and on this fact was based an early method of separating TeS_2 from the sulphides of lead, copper, bismuth, and other metals which are insoluble in that reagent. By digesting the mixed sulphides in the $(NH_4)_2S$ the TeS_2 was supposed to pass completely into solution as ammonium thiotellurite, and from this it was re-precipitated by the addition of dilute HCl (or other suitable acid), oxidised by HCl and $KClO_3$, and the tellurium finally precipitated by the sulphite or other process. In practice, however, this method proved a failure, it being found impossible to effect anything approaching complete separation of the elements, owing no doubt to the dissociation of the TeS_2 first thrown down in the mixed precipitate, the tellurium being then practically insoluble in the alkaline sulphide.

The tellurous solution used in the experiments described below was prepared by dissolving 2·3990 grms. of pure TeO_2 in HCl, and making up to 250 c.c. with water, so that each 50 c.c. taken contained 0·3798 grm. of Te.

Experiment A.—50 c.c. mixed with 200 c.c. freshly made H_2S water, thoroughly shaken, and the mixed solution (contained in a closed vessel) allowed to stand for several hours before being filtered. The precipitate was well washed first with water, and filtered as dry as possible; it was then repeatedly treated with absolute alcohol, and finally extracted with CS_2. The residue left after these operations was dried in a current of CO_2 at 105—110°, and was found to weigh 0·3899 grm., but after being maintained at 250° for three hours its weight diminished to 0·3809 grm., theory for Te being 0·3798. This loss, due to the volatilisation of sulphur insoluble in CS_2 and assumed to be in combination with tellurium, is equal to 2·314 per cent, or 6·870 per cent, of undecomposed TeS_2 in the original precipitate.

Experiment B.—The same volume of solution was taken as in A, and the method of procedure was in every respect similar, only that the extraction with CS_2 was omitted. The precipitate, after drying in a stream of CO_2 at 105—110°, weighed 0·5737, the calculated weight for TeS_2 being 0·5718. By treatment with CS_2 the sulphur was then extracted, and the residue found to consist of practically pure Te, the quantity of insoluble sulphur present being infinitesimal. Thus it would appear that the TeS_2 present in the moist precipitate is in great part dissociated in the process of drying at 105—110°.

Experiment C.—The 50 c.c. of solution diluted to 100 c.c. was saturated with H_2S by passing the gas through it, and the precipitate treated as in A. The insoluble sulphur found in the precipitate was equivalent to 6·986 per cent TeS_2.

Experiment D.—In this case the manner of precipitation was identical with that in A and B, only the precipitate was allowed to remain in contact with the H_2S solution in a closed vessel at a temperature of 75—85° for forty-eight hours before being filtered off, and treated as in A. The insoluble sulphur found corresponded to only 0·958 per cent TeS_2 in the original precipitate.

From these experiments, the details of which I have for obvious reasons had to curtail very considerably, it is apparent that while the precipitate formed by H_2S in acid tellurous solutions contains the elements in the ratio $Te : S_2$, the quantity of presumably combined sulphur in it varies according to the conditions under which it is produced, and also upon its after-treatment. The quantitative value of H_2S precipitation, in an analytical sense, might, under some circumstances, be turned to useful

* With lithium no doublets have been observed, but a large number of simple lines. If the above law applied to this metal, the interval between its doublets would only be 0·016 (about one-tenth that of sodium). It may be that on account of the want of fineness of most of the lines, this interval is too small for the two components of the doublet to be separated.

account, provided always that the conditions under which operations are carried out are such that the ratio between the constituents of the precipitate is not disturbed, and the latter can be weighed as though it were actually the compound TeS_2. It must, however, be remembered that the precipitate is difficult to manipulate, and, moreover, that its liability to contamination with other substances is in itself an objection to the adoption of the method in any other than most exceptional cases.

(b). Action of H_2S on Alkaline Tellurites.

Berzelius discovered that by passing H_2S through an aqueous solution of K_2TeO_3 for a sufficient length of time, two-thirds of the tellurium present separated as a brown precipitate, which soon became almost black, while the remaining third combined with the K_2S also formed in the reaction and passed into the liquid as potassium thiotellurite: $3K_2TeO_3+9H_2S=3K_2S.TeS_2+2TeS_2+9H_2O$. On filtering off the precipitate and evaporating the filtrate over potash or in a vacuum the thiotellurite is obtained in pale yellow needle-shaped crystals. By substituting $(NH_4)_2TeO_3$ for the potassium salt, the thiotellurite, $3(NH_4)_2S.TeS_2$, is obtained, and its solution on evaporation yields yellow quadratic prisms. Thus, then, if TeS_2 cannot, owing to its instability, be obtained in a separate state, it does exist in combination in these interesting double compounds. A solution of either of the alkaline thiotellurites on exposure to air for a time, or quicker on having a current of air blown through it, deposits a dull grey-black non-crystalline substance which the great chemist believed to be TeS_2, but which I find to be only a mixture of the elements which yields up almost the whole of its sulphur to CS_2. Berzelius observed that the precipitate produced by H_2S in an alkaline tellurite solution, and also that formed by the action of an acid on a solution of an alkaline thiotellurite, had at the moment of its formation a reddish-brown colour, which soon darkened and ultimately became almost black. These changes would indicate the probability of the precipitates so obtained being similar in character to those finally resulting from the action of H_2S on acid tellurous solutions. I did not examine the precipitate formed by decomposing alkaline thiotellurites, but in that produced by H_2S in a solution of K_2TeO_3 I found the ratio of the elements to be $Te:S_2$, and the quantity of insoluble sulphur left behind after extraction with CS_2 to correspond to 6·089 per cent of undecomposed TeS_2. This particular precipitate, however, on boiling for several hours in water containing a little HCl, underwent complete decomposition, the whole of the sulphur in it becoming soluble in CS_2.

(c). Action of H_2S on Telluric Solutions.

Berzelius showed that H_2S is practically without action on dilute solutions of TeO_3 in the cold, but that if saturated with the gas and allowed to remain in a warm place for a sufficient length of time, they first acquire a brown colour without losing transparency, and deposit on the sides of the vessel a black-grey metallic-looking film, which he believed to be the trisulphide, TeS_3. In this connection I made the following experiment:—A telluric solution prepared by dissolving 0·5417 grm. $H_2TeO_4.2H_2O$ in 75 c.c. of water was made up to 350 c.c. with freshly prepared H_2S—water which had previously been acidified with 25 c.c. of sulphuric acid (25 per cent H_2SO_4), and the whole set aside in a closely stoppered flask in a cool dark cupboard for ten days. No appreciable precipitation had taken place at the expiration of that time, but on continuously heating the mixed solution at about 75° for nine days, the whole of the tellurium was thrown down in the condition of a grey-black precipitate, which after drying in CO_2 at 105—110° weighed 0·5295 grm, theory for TeS_3 being 0·5274 grm., and which on extraction with CS_2 left 0·3026 grm., being very little over the calculated tellurium originally present in the $H_2TeO_4\,2H_2O$ started with, viz., 0·3000. Thus it is evident that the H_2S precipitate formed in telluric acid solutions does not contain an estimable quantity of combined sulphur, but is composed entirely, or at least nearly so, of an intimate mixture of the elements in the ratio, $Te:S_3$.

(d). The Sulphides of Tellurium.

Tellurium and sulphur can be melted together in all proportions, but it appears that the chemical affinity between the substances ceases at a temperature much below that at which any mixture of them can be fused, and that therefore no definite compound, *i.e.*, sulphide, can be formed in this way.

Some of the results recorded in this paper are necessarily only confirmatory of those obtained by Becker and Brauner, but I have also touched upon several points of interest not dealt with by either chemist, and these I intend to enlarge upon much more fully at some future time, particularly in regard to the thiotellurites and the still less known thiotellurates.

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ON THE

DETERMINATION OF MOISTURE IN HONEY.*

By FRANK T. SHUTT, M.A., F.I.C., F.C.S.,
and
A. T. CHARRON, M.A.

(Concluded from p. 196).

Drying on (a) *Asbestos and* (b) *Sand in Platinum Dishes in Partial Vacuum at 70° C.*

The apparatus used in these trials was exceedingly simple. A tubulated desiccator was placed inside the steam-bath (the same as used in the foregoing experiment) and connected with an exhaust pump attached to the water service. With a current of dry air at the rate of one bubble per second being drawn through the desiccator, a vacuum of approximately 8 inches was maintained. The temperature of 70° C. was without difficulty kept constant for a week or more at a time by almost filling the bath with water and arranging a series of small gas jets (from an S-burner) at a distance of 3 to 4 inches from the bottom of the bath. The flames were protected from draughts by a casing of asbestos-board.

The absorbent materials were sand and asbestos, and platinum dishes (flat and round bottoms) were used in the place of glass tubes.

Table III.—*Moisture in Honey from Fully Capped Comb, as Determined in Partial Vacuum at 70° C.*

Solution A.—60·9166 grms. honey in 500 c.c. (approximately 12 per cent).

Solution B.—25·3596 grms. honey in 500 c.c. (approximately 5 per cent).

Moisture in honey, as calculated for sp. gr. of A = 17·88 per cent.

Moisture in honey, as calculated for sp. gr. of B = 17·46 per cent.

Absorbent material.	Shape of dish.	24 hours.	48 hours.	72 hours.	96 hours.
		From Solution A.			
Sand	F.B.	17·91	18·20	18·67	18·88
	R.B.	17·97	18·24	18·94	19·63
Asbestos	F.B.	20·14	20·83	21 20	21·73
	R.B.	20·16	20 75	21·20	21·98
		From Solution B.			
Sand	F.B.	17·00	17·94	17·94	18·22
	R.B.	16·17	17·12	17·12	17·45
Asbestos	F.B.	22·48	24·89	25·75	26·82
	R.B.	22·83	24·18	25·24	26·15

To compare these results with those obtained by the method previously used, Solutions A and B (using 10 c.c.

* From the *Transactions of the Royal Society of Canada*, vol. viii., p. 35.

in each estimation) were dried at atmospheric pressure in the steam-bath (98° C.) on asbestos in glass tubes, when the following moisture percentages were obtained :—

	24 hours.	48 hours.	72 hours.	96 hours.
Solution A . ..	23·75	26·40	—	—
	24·71	27·12	—	—
Solution B . ..	22·98	30·21	33·92	35·24
	22·20	29·62	32·06	34·05

We now present data of a similar character to those in Table III., but from honey taken from uncapped comb.

TABLE IV.—*Moisture in Honey from Uncapped Comb, as Determined in Partial Vacuum at 70° C.*

Solution.—25·0872 grms. honey in 500 c.c. (approximately 5 per cent).

Moisture in honey, as calculated from sp. gr. = 22·35 per cent.

Absorbent material.	Shape of dish.	24 hours.	48 hours.	72 hours.	96 hours.
Sand	F.B.	21·34	22·65	23·37	23·69
	R.B.	21·52	23·03	23·51	23·99
Asbestos	F.B.	28·45	31·52	33·04	33·32
	R.B.	28·33	31·36	33·04	33·32

The comparative data, drying at 98° C. in steam-bath, using asbestos in glass tubes, are as follows :—

	24 hours.	48 hours.	72 hours.
Percentage of moisture ..	31·34	36·25	40·01
	31·90	36·90	40·53

Drying on (a) *Asbestos and* (b) *Sand in Platinum Dishes in Partial Vacuum at 60° C.*

In all respects, save that of temperature, the conditions of drying were identical with those of the preceding series. The results, given in Table V., appear to show that at this lower temperature (60° C.) twenty-four hours' drying is sufficient for perfect desiccation. As at 70° C., however, the percentages obtained by drying on asbestos are somewhat higher than those when sand is used.

TABLE V.—*Moisture in Honey from Fully Capped Comb, as Determined in Partial Vacuum at 60° C.*

Solution.—59·8312 grms. honey in 500 c.c. (approximately 12 per cent).

Moisture in honey, as calculated from sp. gr. = 17·08 per cent.

Absorbent material.	Shape of dish.	24 hours.	48 hours.	96 hours.
Sand	F.B.	16·88	17·13	17·28
	R.B.	17·62	17·84	18·04
Asbestos	F.B.	18·88	19·24	19·65
	R.B.	18·65	19·20	19·52

The same solution dried on asbestos in glass tubes at 98° C. gave the following results :—

	24 hours.	48 hours.	72 hours.	96 hours.
Percentage of moisture ..	26·27	29·21	30·67	32·26
,, ,, ..	24·66	27·26	28·90	30·33

A review of the results in the foregoing tables allows us to conclude :—

1. That in drying a solution of honey in glass tubes on asbestos, a temperature of 98° C. at atmospheric pressure induces a considerable and continuous dehydration of the levulose, resulting in an apparent loss of moisture far exceeding the real amount present.

2. That drying in glass tubes on asbestos at atmospheric pressure between 70° and 75° C. also occasions a decomposition of the levulose of the honey. It will not suffice, therefore, if accurate results are to be obtained, simply to lower the temperature of the steam-bath as in the second series of experiments.

3. That drying in platinum dishes on sand in a partial vacuum (8 inches) at a temperature of 60—70° C. for twenty-four hours to forty-eight hours, yields results in close accord with those calculated from the specific gravity determinations, and that a more prolonged drying is undesirable, as such appears to induce a slight decomposition of the levulose.

4. That drying on asbestos yields much higher results than drying on sand. This, apparently, is as true at 60° C. as at 70° C. (see Tables IV. and V.), and indicates a peculiar property or quality of the asbestos in inducing decomposition of the levulose.

5. That there were no differences of note between the results from drying in round and flat bottom platinum dishes.

On the Behaviour of Mixtures (*Solutions*) *of Dextrose and Levulose under Varying Conditions of Drying.*

As the saccharine matter in honey consists almost entirely of dextrose and levulose, existing in practically equal proportions, it was considered desirable to ascertain the effect of drying solutions of such a mixture, employing methods involving the same conditions of temperature and pressure as in the foregoing tests with honey.

TABLE VI —*Mixture of Dextrose and Levulose, Drying in Glass Tubes on Asbestos in Steam-bath at Atmospheric Pressure at 98° and 70° C. respectively.*

Dextrose, 5·0009 grms. in 100 c.c.

Levulose, 5·0038 grms. in 100 c.c.

10 c.c. used in each determination = 1·0005 grms.

At 98° C.

48 hours.	60 hours.	80 hours.	93 hours.	120 hours.	132 hours.	140 hours.
Grm.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.
0·909	0·885	0·864	0·846	0·827	0·818	0·815
0·901	0·877	0·856	0·837	0·817	0·810	0·806

At 70° C.

8 hours.	20 hours.	25 hours.	36 hours.	42 hours.
Grms.	Grm.	Grm.	Grm.	Grm.
1·276	0·954	0·951	0·944	0·943
1·172	0·957	0·956	0·948	0·947

TABLE VII.—*Levulose* (*Kahlbaum*), *Drying in Platinum Dishes on Asbestos in Partial Vacuum at 75—80° C. and at 70° C.*

Levulose, 4·465 grms. in 100 c.c.

10 c.c. used in each determination = 0·4465 grm.

Shape of dish.	At 75—80° C. Hours—			At 70° C. Hours—			
	4.	8.	24.	8.	12.	14.	18.
	Grms.	Grm.	Grm.	Grm.	Grm.	Grm.	Grm.
F.B.	3·236	0·437	0·428	—	—	—	—
	3·153	0·426	0·426	—	—	—	—
R.B.	3·205	0·437	0·424	0·584	0·440	0·437	0·434
	3·746	0·438	0·425	0·479	0·438	0·435	0·431
				0·944	0·443	0·442	0·439

TABLE VIII.—*Levulose* (*Diabetin*, "*Schering*"), *Drying in Platinum Dishes on* (a) *Sand and* (b) *Asbestos in Partial Vacuum at 70—75° C.*

Levulose, 5·472 grms. in 100 c.c.

10 c.c. used in each determination = 0·5472 grm.

Absorbent material.	Shape of dish.	24 hours.	48 hours.
		Grm.	Grm.
Sand	F.B.	0·5385	0·5309
	R.B.	0·5404	0·5290
	R.B.	0·5386	0·5314
Average		0·5392	0·5304
Asbestos	F.B.	0·5293	0·5239
	R.B.	0·5288	0·5206
	R.B.	0·5276	0·5214
Average		0·5286	0·5219

TABLE IX.—*Levulose (Kahlbaum), Drying in Platinum Dishes on* (a) *Sand and* (b) *Asbestos in Partial Vacuum at 60° C.*

Levulose, 5·2228 grms. in 100 c.c.
10 c.c. used in each determination = 0·52228 grm.

Absorbent material.	Shape of dish.	21 hours.	25 hours.	43 hours.	48 hours.
Sand	F.B.	0·543	0·525	0·525	0·525
	R.B.	0·905	0·528	0·528	0·528
Asbestos	F.B.	0·539	0·510	0·510	0·509
	R.B.	0·534	0·507	0·506	0·505

General Deductions from Data in Tables VI. to IX.

The results given in Table VI. show a considerable loss due to decomposition on drying a mixture of dextrose and levulose on asbestos for forty-eight hours at 98° C., and this loss constantly increased. At a temperature of 70° C. (atmospheric pressure), eight hours' drying was insufficient, but an additional period of twelve hours proved too long.

From Table VII. it is apparent that a temperature of 75—80° C. (using asbestos and drying in a partial vacuum) is too high. A drying period of eight hours was sufficient to show that decomposition had commenced. Under the same conditions, but at 70° C., a period of twelve hours furnished results indicating a thorough desiccation of the levulose, but no decomposition. Further drying, however, undoubtedly caused dehydration of the sugar.

In the results of Table VIII. the relative value of sand and asbestos as absorbent materials is compared at 70—75° C. As in the case of honey, we find that with asbestos there is a greater loss on drying than when sand is used. In twenty-four hours the loss through decomposition, using sand, is about 1·4 per cent, whereas with asbestos it is approximately 3·4 per cent. At forty-eight hours these losses, respectively, are practically 3·1 per cent and 4·6 per cent.

The data furnished in Table IX. are indicative that twenty-five hours drying in a partial vacuum at 60° C. on sand is sufficient for desiccation of the levulose, and that there is no decomposition or further loss on continued drying. In the case of asbestos, under the same conditions, there appears to be decomposition (between 2 per cent and 3 per cent) of the levulose. It is evident that even at this low drying temperature sand is the preferable absorbent.

The results of the work on levulose solutions agree very well on the whole with those obtained on solutions of honey. It has already been shown that drying the latter from twenty-four to forty-eight hours at 60—70°C. in a partial vacuum on sand, gave percentages in close accord with those obtained from the specific gravity determinations. The investigations with levulose solutions prove that a temperature of 60° C., in a partial vacuum using sand, furnished figures approximating the amounts weighed out. It is probable that a temperature of 70° C. could be safely used if the pressure were reduced to, say, 6 or 8 inches, but with the partial vacuum that we were able to maintain it is evident that the drying temperature should be as close as possible to 60° C.

School Board for London.—The Annual Exhibition of work from the Day, Evening Continuation, Truant, Industrial, Blind, Deaf, and Physically and Mentally Defective Schools, will be held at the Examination Hall, Victoria Embankment, W.C., on Saturday, May 9th next, from 12 noon till 10 p.m., and on the following Monday, Tuesday, and Wednesday (May 11th, 12th, and 13th), from 10 a.m. till 10 p.m. The Exhibition will be opened at 12 o'clock noon on May 9th by the Right Hon. Lord Reay, G.C.S.I., G.C.I.E., Chairman of the Board. Admission to the Exhibition is free, but tickets are required for the opening ceremony.

THE

TITRIMETRIC ESTIMATION OF NITRIC ACID.*

By I. K PHELPS.

In the methods for the quantitative estimation of nitric acid which depend upon its reduction with a ferrous salt and the determination of the amount of oxidation produced, scrupulous care is necessary that the atmosphere in contact with the ferrous salt while the nitrogen dioxide is present shall be free from oxygen. This fact was recognised by Fresenius (*Ann.*, cvi., 217; *Zeit. Anal. Chem.*, i., 32), who modified the original process of Pelouze (*Ann. de Chim. Phys.*, [3], xx., 129) by filling the flask with carbon dioxide or hydrogen at the outset. Eder (*Zeit. Anal. Chem.*, xvi., 267) used carbon dioxide similarly. Holland's method (CHEMICAL NEWS, xvii., 219), roughly described, consists in boiling, until the air is expelled, the solution of the nitrate in a flask provided with a doubly bent exit tube, rubber-jointed, and fitted with a pinchcock, then admitting through the tube as the flask cools a mixture of ferrous salt and strong hydrochloric acid, heating the mixture on a water-bath, and, finally, titrating the resulting ferric salt with stannous chloride.

All of these methods give results which are higher than the theoretically expected—those which use carbon dioxide on account of the oxygen invariably present in the gas as ordinarily produced in the laboratory, and Holland's process possibly because of the slow leakage through the rubber connections during the long heating, or because the nitrogen dioxide, which is not driven out completely from the solution of the iron salts, acts somewhat with the atmospheric oxygen during the titration.

Another series of methods has depended upon the determination of the nitrogen dioxide evolved, usually by direct measurement as nitrogen dioxide. Among these may be mentioned the methods of Schloessing (*Ann. de Chim. Phys.*, [3], xl., 479), Reichart (*Zeit. Anal. Chem.*, ix., 26), Schulze and Wulfert (*Zeit. Anal. Chem.*, ix., 400), Tiemann ("Anleitung zur Untersuchung von Wasser," von W. Kubel, Zweit Auflage, von F. Tiemann, 55), Wildt and Scheibe (*Zeit. Anal. Chem*, xxiii., 151), Warington (*Journ. Chem. Soc.*, xxxvii., 468; xli., 345), Boehmer (*Zeit. Anal. Chem.*, xxii., 20), Kratschmer (*Zeit. Anal. Chem.*, xxvi., 608), Wilfarth (*Zeit. Anal. Chem.*, xxvii., 411), Morse and Linn (*Am. Chem. Journ.*, viii., 274), Berger (*Chem. Zeit.*, xix., 305), and Roberts (*Am. Journ. Sci.*, 1893, xlvi., 126). In general, these methods give results lower than demanded by the theory—in many cases, on account of the solubility of the nitrogen dioxide in the ferrous solution used as a reducer, and, in other cases, on account of the solubility of that gas in the solution of sodium hydroxide over which it is measured. Further, there is the effect of oxygen upon the nitrogen dioxide; if present in the measuring burette in the proportions found in air, it will not give any appreciable effect in moderate amounts, as was observed by Roberts; but if it is present while the gas is in contact with the ferrous solution, the nitrous or nitric acid formed will be taken up by the solution, and, should the oxygen be introduced continuously, as an impurity in carbon dioxide furnished by a Kipp generator, the iron salts will never be free from oxidised nitrogen. If, however, the oxygen is present in some other proportion of dilution than that of the air—as, for example, in the proportion in which it dissolves in aqueous solutions—it will produce an error no matter whether it comes in contact with the gases of the ferrous solution or those of the collecting burette; in the example taken, the proportion of oxygen being greater than that in the air, the error produced is one of deficiency. The effect of oxygen has been recognised before. For example, in his process of determining nitrates by re-

* Contribution from the Kent Chemical Laboratory of Yale University. From the *American Journal of Science*, xiv., p. 440.

ducing them with ferrous salt and hydrochloric acid in an atmosphere of carbon dioxide (furnished by the action of hydrochloric acid on marble), boiling the ferrous solution completely to dryness, collecting the gases over mercury, absorbing the carbon dioxide by sodium hydroxide solution, and the nitrogen dioxide by repeated treatment with a concentrated solution of ferrous salt, Warington found that, when the carbon dioxide was made as free from air as possible by using marble boiled in water, and hydrochloric acid also boiled, and adding a little cuprous chloride to the acid, the results were decidedly better.

The estimation of the amount of oxidation of a ferrous salt may be accomplished with a simpler apparatus than that required when the nitrogen dioxide is measured, and the purpose of this article is to put on record such a method, following most nearly the procedure of Holland. The apparatus used consisted of a 250 c.m.³ flask closed with a rubber stopper carrying in two perforations the inlet and exit tubes. A stoppered funnel of 50 c.m.³ capacity with its tube constricted at its lower end was used as the inlet tube; and a glass tube of 0·8 c.m. internal diameter, enlarged just above the stopper to a small bulb (to prevent mechanical loss of the solid contents of the flask during the boiling), and bent twice at right angles, served as the exit tube.

The analysis was made as follows:—A solution of ferrous sulphate, mildly acidified with sulphuric acid, was made of about one-fifth normal strength, and standardised against standard decinormal arsenious acid solution by treating portions of it, measured from a burette (and weighed as a check on the burette readings) with an excess of decinormal iodine solution, adding about 3 grms. of Rochelle salt in solution, neutralising with acid potassium carbonate, and adding in succession 15 c.m.³ of a saturated solution of acid potassium carbonate, starch paste, and then standard arsenious acid solution to the bleaching of the starch blue, and, finally, titrating to colour with the iodine solution. For the determination of nitric acid, the pure potassium nitrate of commerce was used. In the smaller amounts, the nitrate was taken in a solution of known strength measured from a burette, and in the larger amounts as the dry salt. When the solution of nitrate was used, it was measured into the flask, the stem of the separating funnel being completely filled with water, and the exit tube of the flask reaching to the surface of mercury which was placed in a test-tube to the depth of about 3 c.m. The nitrate solution was then boiled to small volume, an amount of the standardised ferrous sulphate solution known to be in excess introduced into the separating funnel, the exit tube plunged a centimetre or two deep into the mercury (which is readily accomplished by changing the position of the flask on the wire gauze, provided that the gauze is depressed well at the centre, and the flask is set well up on the higher part at the beginning of the operation), and then the flame withdrawn until diminution of pressure sufficient to draw the ferrous solution into the flask is made evident by the rise of the mercury in the exit tube. By applying and withdrawing the flame, and by regulating the rate of inflow of the solution, the ferrous salt may be introduced without admitting air, and the funnel washed carefully with an amount of concentrated hydrochloric acid nearly enough to equal the total volume of the liquid in the flask. After the pressure has been restored in the apparatus by heating the flask, the exit tube is again raised to the surface of the mercury, and the solution in the flask boiled to a volume of 10—15 c.m.³. The excess of acid is then nearly neutralised with sodium carbonate solution, the carbon dioxide evolved assisting in maintaining the pressure in the apparatus, so that the condensed liquid in the test-tube which may contain oxidised nitrogen dioxide is not returned to the iron solution; the flask is cooled, and the ferrous salt remaining determined by iodine as previously described, or by a standard solution of potassium permanganate. In case permanganate is used, the contents of the flask are diluted with 600 c.m.³ of water, 2—3 grms. of crystallised manganous chloride (Gooch and Peters, *Am. Journ. Sci.*, 1899, vii., 461), and titrated to colour with potassium permanganate. In the experiments where the dry salt was used, the air was expelled from the apparatus by boiling 10 c.m.³ of water to small volume in the flask arranged as previously described, the ferrous sulphate solution introduced, and concentrated by boiling to a volume of about 20 c.m.³, so that the amount of acid used may not be so large; then, the nitrate, dissolved in a small amount of water, was allowed to flow in, and was finally washed in, as before, with an amount of concentrated hydrochloric acid, which approximates in volume that of the liquid contents of the flask.

Experiments numbered I.—VIII., inclusive, of the following table show the results of a series of experiments made as described above.

	KNO_3 taken.	Oxygen value of ferrous salt taken.	Oxygen value of ferrous salt found.	Error on oxygen.
	Grm.	Grm.	Grm.	Grm.
I.	0·0500	0·01823	0·00621	0·00015 +
II.	0·0500	0·01865	0·00681	0·00003 −
III.	0·0500	0·01954	0·00768	0·00000 ±
IV.	0·1000	0·02881	0·00507	0·00001 +
V.	0·1000	0·02822	0·00441	0·00008 +
VI.	0·2500	0·06453	0·00512	0·00009 +
VII.	0·5000	0·13394	0·01524	0·00005 +
VIII.	0·5000	0·12210	0·00340	0·00005 +
IX.	0·0500	0·01720	0·00747	0·00214 −
X.	0·0500	0·01550	0·00389	0·00026 −
XI.	0·0525	0·01550	0·00318	0·00014 −
XII.	0·1000	0·02765	0·00432	0·00040 −

Experiments numbered IX. and X. were made to determine whether the long boiling in the previous experiments is actually necessary; for in the work by Fresenius, as well as that of Eder, directions are given merely to boil the hydrochloric acid solution of the iron salt with the nitrate until the colour of the dark compound of the nitrogen dioxide with the ferrous salt wholly vanishes and is replaced by the clear colour of the ferric salt, which means an active boiling of not longer than five minutes in the experiments recorded in the table. Experiment IX. was made exactly like the similar ones above it in the table, except that the boiling was interrupted after the dark coloured ferrous compound with the nitrogen dioxide was completely broken up; and experiment X. similarly, except that the boiling was continued for five minutes after the complete disappearance of the dark colour. Obviously the period of boiling allowed by Fresenius and Eder is not enough, but since the main error incidental to these processes is an error of excess due to oxygen present, as already stated, it will readily appear how this second error, which is one of deficiency, and hence correcting the first error, may have been overlooked.

Ferrous ammonium sulphate has been recommended by Austin and Chamberlain (*Am. Chem. Journ.*, v., 209), and by Rosa (*Gazz. Chim. Ital.*, xv., 295) as more convenient, stable, and sensitive than the crystalline ferrous sulphate. It would seem possible that nitric acid might act as an oxidising agent on the ammonium salt, and certainly nitrous acid (if it were produced, as might be, as an intermediate product in the reduction of nitric acid to nitrogen dioxide) would act according to the equation, $NH_4Cl + HNO_2 = HCl + 2H_2O + N_2$. Such an action either of the nitric acid or nitrous acid would produce an error of deficiency. Experiments XI. and XII. were made to test this point, being made exactly like those numbered I.—VIII., except that 1 grm. of crystallised ammonium sulphate was added with the ferrous salt. The results show slight but appreciable losses.

The concentration of the hydrochloric acid in this operation does not allow of much diminution under these conditions, where immediate reduction of the nitric acid without any volatilisation is a necessity—a fact which has

been recognised before by Roberts and obviated under the conditions there used.

Thus it would appear—

First. That the method outlined above is capable of yielding very accurate results, affording as it does an easy and complete means of shutting out oxygen from the nitrogen dioxide while that gas is in contact with the ferrous salt.

Second. That prolonging the boiling only until the dark coloured compound of nitrogen dioxide with ferrous salt is broken up, results in the incomplete reduction of the nitric acid.

Third. That ammonium salts must be absent if the highest accuracy is desired.

NOTICES OF BOOKS.

A Text book of Organic Chemistry. By A. F. Holleman. Translated from the Second Dutch Edition by A. Jamieson Walker, assisted by Owen E. Mott. With the Co-operation of the Author. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1903. xvii.—555 pp., 8vo. Ill. Also issued in two parts; Part I., Introduction and Fatty Compounds. Part II., The Aromatic Compounds and Substances related to them.

This forms a companion volume to the author's "Text-book of Inorganic Chemistry," translated by Hermon C. Cooper, and published by the same firms in 1902; and in it the same high plane is maintained. Dr. Holleman has endeavoured to keep the number of unconnected facts within as narrow limits as possible, to avoid confusing the beginner, and he has given prominence to underlying theories. For most of the compounds proof of their structure is given, but the methods of orientation employed for the higher substitution products of the aromatic series are described in a separate chapter. Features of this comprehensive text-book named in connection with the notice of the first volume are introduced into the second wherever the nature of the subject permits; prominence is given to the modern physico-chemical theories, such as the laws of equilibrium, ionisation, &c. Some of the more important technical processes are briefly discussed.

Structural, displayed formulæ are freely used, and the text explaining the reasons for so representing the bodies is unusually clear; at several points stereo-isomerism receives due attention. Space is found to notice some unusual compounds, such as the tertiary bismuthines, Grignard's magnesium alkyls, and certain esters, yet the author disclaims any attempt to make the book a "Beilstein."

The contents of the volume are set forth in an unusually full table occupying nine pages, and there is also an ample index of twenty-seven pages, facilitating reference.

To point out more admirable features would make this notice read like a table of contents, and we conclude by strongly recommending this thoughtful philosophical text-book. Both volumes are well clothed, as usual with these publishers; and taking bulk, as well as quality, into consideration, the price is low. H.C.B.

A Short Manual of Inorganic Chemistry. By A. Dupré, Ph.D., F.R.S., &c., and H. Wilson Hake, Ph.D., F.I.C., &c. Third Edition (re-issue). London: Charles Griffin and Co., Ltd. 1903. Pp. 391.

In a publisher's note we read that the opportunity has been taken of the re-issue of this popular work to meet an urgent request of many teachers for a less expensive edition. The present edition, while retaining the main features of the preceding editions, has been thoroughly revised and partly re-written, with special reference to the periodic law, and has thus undergone some material alterations.

The growing importance of physical chemistry, and especially of thermo-chemistry, has necessitated considerable alterations and additions to the introductory portion of the book. In the descriptive part, which commences on page 102, the authors have adhered to the arrangement outlined in their "Scheme of Properties," but they have adopted the periodic system of classification, and have taken the elements in the order of grouping according to Mendeleeff's table, which is given on page 98. The book is well written, and the descriptions are clear and ample. There is a short appendix containing a few useful tables, and a very full index of thirteen pages of two columns each.

Logarithmic Tables for Chemists ("Logarithmische Rechentafeln für Chemiker"). By Dr. F. W. Kluster. Third Edition, Revised and Englarged. Leipsic: Veit and Co. 1902. Pp. 93.

Besides a useful table of five-figure logarithms from 100 to 9999, and a supplementary one from 10 to 99, the author has given a number of other tables which will be of great convenience to those who have many calculations to make on chemical matters. Among these other tables we may mention those of the atomic weights of all the elements, and their logarithms, factors and their logarithms for finding the weight of any element from various salts, the molecular weights of a large number of salts and their logarithms, and similar tables for use in the volumetric estimation of gases, &c.; the whole collection being bound in a convenient form.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Bulletin de la Société Chimique de Paris.
Series 3, Vol. xxvii., No. 22.

The Acid Reaction of the Alums, and the Influence of this Acidity on the Insolubilisation of Gelatin in the case of Chrome-alum.—MM. Lumière and Seyewitz.—The authors have examined the cause by which the alums may be treated with a considerable amount of alkali without the precipitation of the oxides, and they have determined, in the case of each alum, what quantity of alkali corresponds to the persistent precipitation of the oxide. They have also examined the difference between the insolubilisation by means of neutralised chrome-alum, and the same unneutralised, with a view to determining the best conditions to obtain the most complete insolubilisation, and they found that the best results were obtained by treating the alum with an alkali until a slight persistent precipitate was formed.

Estimation of Sulphurous Acid by means of a Titrated Iodine Solution.—A. Berg.—Already inserted in full.

Synthesis of the Ketones and Acylacetones starting from the C-acylacetic Ethers.—E. Bouveault and A. Bongert.—When a C-acylacetic ether is heated with concentrated hydrochloric acid to 130—140° in a sealed tube, we obtain carbonic acid, alcohol, acetic acid, and a ketone, according to the equation—

$$CH_3—CO—\underset{\displaystyle CO—R}{\overset{\displaystyle |}{CH}}—CO_2R' + 2H_2O =$$

$$= CH_3—CO_2H + \underset{\displaystyle CO—R}{\overset{\displaystyle CH_3}{\overset{\displaystyle |}{}}} + CO_2 + R'OH.$$

The reaction is quasi-integral; the authors have applied it, in particular, to C-butyrylacetylacetate of methyl,

which gave methylpropylketone, recognised by its odour and its boiling-point. When a C-acylacylacetic ether is heated with water to 140—150°, in a sealed tube, an acylacetone is formed, as well as carbonic acid, and the alcohol corresponding to the ether originally used. Experiments show that the acylacetones have most of the characteristic properties of acetylacetone.

Synthesis of Acylacetic Ethers by means of the C-acylacetylacetic Ethers. — L. Bouveault and A. Bongert.—An excess of boiling dilute potash decomposes the C-acylacetylacetic ethers according to the equation—

$$CH_3—CO—CH(CO—R)—CO_2R' + 3KOH = CH_3—CO_2K + CH_3(CO—R) + CO_3K_2 + R'OH.$$

The authors thought that by conducting this reaction more carefully they might be able to obtain a product of an intermediate decomposition. They have studied this reaction in detail on C-butyrylacetylacetate of methyl, and describe a number of products obtained.

Reactions and Decompositions of C-acylacetylacetates.—L. Bouveault and Bongert.—In this paper the authors give the results obtained from their experiments on the reactions of the C-acylacetylacetates with hydrazine and phenylhydrazine; for this purpose they used the butyrylacetylacetate of methyl.

Action of the Chlorides of the Acids on the Soda-derivatives of the Substituted Acetylacetic Ethers.—L. Bouveault and A. Bongert.—If the sodium salt of butyrylacetylacetate of methyl is treated with iodide of methyl, either in the dry state or in ethereal solution, no reaction takes place; but if we add alcohol, or what comes to the same thing, if we add iodide of methyl to the mixture of C-butyrylacetylacetate of methyl and methylate of sodium, after a few minutes a slight heating takes place; this increases until the boiling-point is reached if the solution is not sufficiently dilute. After standing a few hours, the alcohol and the iodide of methyl are driven off on the water-bath *in vacuo* until the precipitation of the iodide of sodium puts a stop to the distillation; the product is poured into water, and an oily layer is formed immediately, which is extracted with ether. This ether is driven off on the water-bath, and the product re-distilled *in vacuo*. As the reaction took place in a manner which appeared to be entirely normal, the authors expected to obtain the methylbutyrylacetylacetate of methyl, a liquid boiling at about 110° at 10 m.m.; but they were astonished to find a colourless liquid with an agreeable odour boiling at only 89—90° at 16 m.m., of density at 0° and 4 m.m. = 1·005. Analysis gave figures corresponding with the formula $C_8H_{14}O_3$. Thus the expected body was decomposed at the moment of its formation, losing an acetyl group; in fact, the compound $C_8H_{14}O_3$ constitutes methylbutyrylacetate of methyl. The authors subjected this new body to an extended examination, and amongst other experiments they combined it with phenylhydrazine and with hydrazine.

Some Derivatives of Azobenzene and of Hydrazobenzene.—P. Freundler and L. Beranger.—This research, of which the results are given in this paper, was undertaken with the object of preparing the alcohols, aldehydes, ketones, and the acid derivatives of azobenzene. These compounds, which have the general formula $C_6H_5—N=N—C_6H_4—R(R=CH_2OH,CHO)$, &c., have a certain interest from the point of view of their odour. The authors then describe three methods by which the dissymmetric derivatives of azobenzene may be obtained.

Examination of Essence of Vervein from Grasse.—Eug. Theulier.—The essence examined was obtained by the distillation of the fresh leaves of the *Verbena triphylla, L.*, from the neighbourhood of Grasse; 180 kilos. of leaves gave 130 grms. of essence, or 0·72 per cent. After filtration the essence obtained had the following properties:—

Density at 13°	1·919
Rotatory power	−16° 20′
Ethers, as acetate of linalyl	11·20 per cent

It is insoluble in alcohol at 80°, but soluble in its own volume of alcohol at 90°; on the addition of a further quantity of alcohol it does not become cloudy, but small, white, very brilliant flakes separate out. When the ethers are estimated, the solution of alcoholic potash immediately causes a bright red colouration. This essence contains only a small proportion of aldehydes (20·80 per cent), but it is characterised by the presence of a stearoptene fusing at 62·5°, and easily separated on cooling. It contains, besides citral, levogyre limonene, geraniol, and a sesquiterpene.

Methylanthranilate of Methyl in the Vegetable Organism.—Eugene Charabot.—Already noticed.

The Use of Animal Charcoal in the Analysis of Wines; its Advantages and Disadvantages. — M. Carimantrand.—Not suitable for abstraction.

A New Apparatus for the Estimation of Nitrogen.—Ch. Porcher and M. Brissac.—Requires the accompanying diagram.

The Nature of Bufonine.— G. Bertrand.—The author is of the opinion that Faust's bufonine is not a new principle; it is simply ordinary levogyre cholesterine contaminated by various impurities, among which a small amount of bufotaline gives it a certain activity on the heart of a frog.

MISCELLANEOUS.

The Existence of the Blue or Green Modification of Sulphur.—N. A. Orlaf.—In a previous paper the author has described the formation of blue or green sulphur by the action of S_2Cl_2 on certain metallic sulphides in the presence of organic solvents. The colouration of the sulphur thus produced is not due to organic mixtures; this has been proved by analysis, and also by the fact that the presence of the organic solvent is not indispensable. Neither is it due to the presence of polysulphurised or chlorosulphurised compounds, for the coloured sulphur has no action on sulphuretted hydrogen, and its transformation by means of alcohol gives a white material, and not a black (Bi_2S_3) or yellow (CdS) one. The author describes various reactions which give rise to the formation of green or blue sulphur; the conclusions to be drawn from his experiments may be summarised as follows:—1. A large number of facts tend to prove that a blue or green (caused by mixing with the yellow sulphur) modification of sulphur does exist, but it is very unstable, and can only exist under certain special conditions, such as fixation on the metallic chlorides at the moment of its separation from certain compounds, the presence of certain mineral or organic compounds. 2. Among the conditions favourable to the formation of blue sulphur, we must note particularly the phenomena of apparent dissociation and the reactions which remain incomplete; the reaction of Caraves Gil, which consists of pouring a few drops of a solution of a polysulphide of Na, K, NH_4, or Ca into concentrated boiling alcohol; a blue or bluish-green colouration is formed, which disappears on the addition of an alkali or of any other substance capable of decomposing the polysulphide; the alcohol may be replaced by acetone. In this connection we may mention the experiments of Nöllner (decomposition of KCNS alone, or in the presence of KOH), and of Geutner (action of heat on a solution of SO_2 in sealed tubes in the presence of $BaCO_3$, $SrCO_3$, &c.) as giving blue sulphur. 3. The structure of blue sulphur is uncertain, but in any case the reaction of CdS on S_2Cl_2, the experiments of Geutner, and even the

colour of the product, would point to a structure similar to that of ozone (S_3). The preparation of blue sulphur in a pure state offers difficulties as great as the preparation of pure ozone. Although the blue sulphur may be very unstable in the free state, it may form a very stable chromophore group when fixed with certain substances. The author thinks that we might look upon sulphur as the chromophore of certain mineral colours, particularly of ultramarine.—*Journ. Soc. Phys. Chim. R.*, vol. xxxiv., p. 52.

The Hydrates of Calcium Oxide.—F. F. Sélivanof.—The author has succeeded in strongly concentrating a solution of $Ca(OH)_2$ in water by congelation. He obtained a new crystallised hydrate, $Ca(OH)_2.H_2O$; these crystals have a very strong double refraction; they do not contain any CO_2. The author has examined the solubility of $Ca(OH)_2$ in dilute solutions of sugar, and finds that amorphous $Ca(OH)_2$ is more soluble than crystallised $Ca(OH)_2$.—*Journ. Soc. Phys. Chim. R.*, vol. xxxiv., Part 2, p. 14.

MEETINGS FOR THE WEEK.

MONDAY, 4th.—Society of Arts, 8. (Cantor Lectures). "Mechanical Road Carriages," by W. Worby Beaumont, Mem.Inst.C.E.
—— Society of Chemical Industry, 8. "Problems in the Fat Industry," by Dr. Julius Lewkowitsch. F.I.C.
—— Royal Institution, 5. General Monthly Meeting.

TUESDAY, 5th.—Royal Institution, 5. "The Blood and some of its Problems," by Prof. Allan Macfadyen, M.D., &c.
—— Society of Arts, 4.30. "The Lagos Hinterland—its People and its Products," by Major J. H. Ewart.

WEDNESDAY, 6th.—Society of Arts, 8. "The Construction of Maps and Charts," by G. J. Morrison.
—— Society of Public Analysts, 8. "Existing Defects and Possible Improvements in the Laws relating to Adulteration," by Alfred H. Allen, F.I.C. "The Composition of Milk," by H. Droop Richmond, F.I.C.

THURSDAY, 7th.—Royal Institution, 5. "Hydrogen — Gaseous, Liquid, and Solid," by Prof. Dewar, F.R.S., &c.
—— Chemical, 8. "β-Bromonitrocamphor and β-Bromocamphoryloxime—Influence of Impurities in Conditioning Dynamic Isomerism" and "Spontaneous Decomposition of Nitrocamphor," by T. M. Lowry. "The Active Constituents of *Butea frondosa*," by E. G. Hill.

FRIDAY, 8th.—Royal Institution, 9. "Rural England," by H. Rider Haggard.
—— Physical, 5. "A Spectroscope of Direct Vision and Minimum Deviation," by T. H. Blakesley. "Mathematics of Bees' Cells," by Prof. Everett. "The Coloured Map Problem," by W. H. Price. "Note on the Construction and Attachment of Galvanometer Mirrors," by Dr. W. Watson.

SATURDAY, 9th.—Royal Institution, 3. "Music" (with Musical Illustrations), by Hamish MacCunn.

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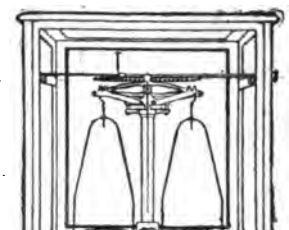

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VOL. LXXXVII., No. 2267.

CAMBRIDGE CEMENT-STONES.

By EDWY G. CLAYTON, F.I.C., F.C.S.

DURING recent years the hydraulic cement industry has been largely carried on in the valley of the river Rhee or Cam, a short distance south-west of Cambridge. The names of the places marking the direction of that part of the valley are Trumpington, Hauxton, Haslingfield, Harston, Barrington, Foxton, Shepreth, and Meldreth. Several cement works are situated in this district, and the products are claimed to be equal to Portland cement from the Thames and Medway. The river flows through Upper Cretaceous strata; the chalk marl and lower chalk being well developed on the right bank, the gault on the left, and along the course of the stream is a tract of alluvium of varying width.

The results of analyses of some specimens of cement-marl, &c., from the neighbourhood are given in the accompanying table.

	Cement-marl.								Grey chalk.	Boulder clay from the district.
Sample	1.	2.	3.	4.	5.	6.	7.	8.		
Silica	18·15	23·39	25·20	21·75	22·00	13·75	14·67	16·43	5·48	47·58
Calcium carbonate (*a*) ..	70·15	65·44	67·57	70·80	71·16	79·30	79·27	75·92	87·94	36·51
Iron oxide and alumina ..	5·72	3·05	3·82	2·71	3·44	2·11	2·05	2·42	1·20	10·12
Magnesia, alkalis, &c. ..	2·74	5·31	0·17	0·73	0·67	1·72	0·43	2·04	4·81	3·55
Loss at 100°	3·24	2·81	3·24	4·01	2·73	3·12	3·58	3·19	0·57	2·24
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

(*a*) Equals an average of 74·88 per cent on the samples of marl, dried at 100° C.

Chemical Laboratory,
32, Holborn Viaduct, London, E.C.,
April 28, 1903.

SLIPSHOD METHODS OF OIL AND PAINT ANALYSIS, AND THE TWENTIETH CENTURY NEGLECT OF INORGANIC CHEMISTRY.

By JOHN GEDDES McINTOSH.

WITH the exception of the chemistry of the rare metals, the present-day neglect of inorganic chemistry is very palpable and much to be regretted. Prof. Reynolds' suggestion (in his Address summarised in the CHEMICAL NEWS, vol. lxxxvii., p. 188) that inorganic chemistry should receive more attention is highly opportune. If evidence of this were required it is to be found in the slipshod methods of inorganic analysis given in most books dealing with the technology of substances which fall within the domain of organic chemistry. Take the determination of the inorganic substances dissolved in oils either for increasing their lubricating or drying propensities. Two of the most important ingredients are lime and lead compounds. Lime is detected and estimated without removing lead, and lead is estimated without separation from lime, and so on. One would think the authors of the text-books in question had never gone through the group separations in their life, and yet these men are looked up to as authorities, and are the parents of organic substances the formulæ for which would almost require a folio page of the "Encyclopædia Britannica" to thoroughly display. But the pity of it all is that the ordinary layman is apt to attribute no value whatever to formulæ which owe their parentage to so-called authorities who by their writings show that they are ignorant of the mere rudiments of inorganic analysis. It is, in fact, only too highly probable that their organic separations are as faulty as their inorganic ones. The same is the case with most of the schemes for the analyses of mixed paints; lead is again prescribed to be estimated without separation from lime, and so on.

Take the text-books on oils again. Page after page are taken up with the so-called constants of oils—the data given being of no value whatever except in regard to the particular sample operated on. But they have the mischievous effect of confusing those who consult such treatises in the search for information. Then, to show how far these so-called authorities appreciate and understand the results of those in the field before them, Allen's figures, as given in his "Commercial Organic Analysis," are quoted as if they were the results of a series of analyses made by Allen personally. I was always under the impression that these figures were the *maxima* and *minima* of the results obtained by all and sundry up to the publication of Allen's book, but that it did not necessarily follow that Allen had made *all* these determinations personally.

It almost looks as if the compilers of these so-called "constants" took a savage delight in piling up elaborately designed tables for the express purpose of confusing the reader, and that the more he succeeded in doing so, the more he gloated over his handiwork. It is high time that these "constants" were "wiped off the slate," and something *less variable* put in their place. No two animal or vegetable oils of the same nature are absolutely identical, but it is giving the student of oils altogether an erroneous idea to lead him to the belief that they vary within the highly wide range of the piles of so-called constants. If they vary there is a cause for it, and efforts should rather be made to discover the cause of the variation than to register the results in the hope of their being added to the already enormously swollen tables of results of no value except in regard to the individual samples of oil to which they refer. Again, the term "value," as used in "saponification value," &c., is not a very intelligible one. It may be the literal meaning of the German *Zahl*, but it has not got the meaning in English which it is intended to convey in the technical sense in which it is used. Not only so, but far from affording a complete means of *valuing* an oil, it is merely an *indication*, and taken by itself in many cases an unreliable *indication* at the best. Again, prefixing a man's name in front of "value" makes it still more ridiculous; and, as if this were not enough, in the case of the so-called "Reichert value" we must needs express an acid determination in terms of c.c. of decinormal potash! The absurdity of this latter method of expression was recently animadverted on by two French Government Agricultural Chemists. The nomenclature of oil analysis, or the words in which the results are expressed, are sadly in want of revision.

9, Parsonage Street, Cubitt Town, E.

THE STRUCTURE OF SPECTRA.*

By Prof. CH. FABRY.

(Continued from p. 209).

III. *The Series.*

THE groups present in a spectrum are not isolated one from the other, they are arranged in natural families which we will call series.

The first example of a series of lines was discovered in the hydrogen spectrum. Fig. 1 shows this spectrum on the scale of frequencies, as found by Cornu's measurements; the intensity of the different lines is indicated roughly by the thickness of the marks.

Since then, Messrs. Hale and Deslandres have discovered, in the spectra of solar protuberances and of certain stars, 16 other lines belonging to the same series, which brings the total number up to 28, all of which are represented very accurately by Balmer's formula.

The spectra of the metals show series entirely analogous to those of hydrogen; instead of simple lines, the elements of these series will be the doublets or triplets of which we have already spoken, and a single metal will give several distinct series, related to each other by very simple laws. As these series confuse each other, most careful observations have been necessary to separate them, while in the case of hydrogen it was sufficient, as shown by Cornu, to free the spectrum of all strange lines to see the series unique in all its simplicity.

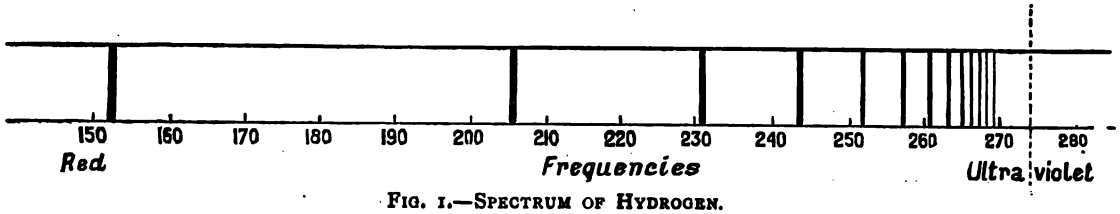


FIG. 1.—SPECTRUM OF HYDROGEN.

A simple glance suffices to show that these lines are not placed haphazard. Their intensities diminish regularly at the same time as the wave-lengths, as well as the distance from each line to the next. They seem to tend towards a limit which would correspond to the frequency 274, or to the wave-length 364·6 $\mu\mu$. To show this regular distribution more precisely, let us project this spectrum on a graphic curve; the lines must be numbered from 3 to 15, and for each line we will plot the numbers of the order m as abscissæ, and the frequencies N as ordinates. We see in Fig. 2 that the points form a

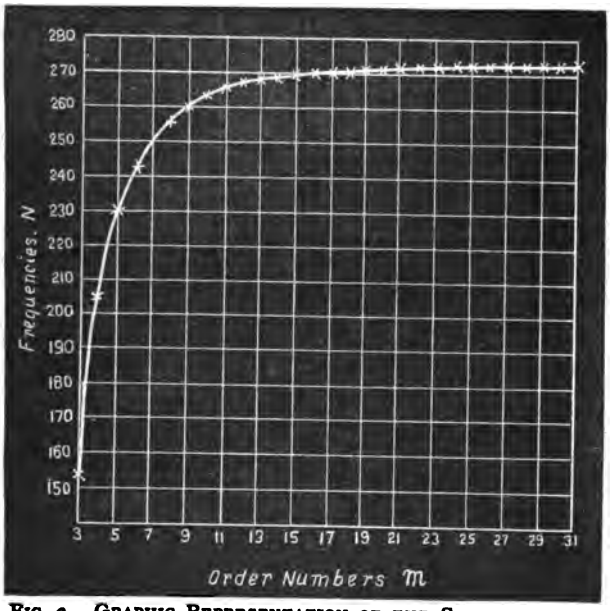


FIG. 2.—GRAPHIC REPRESENTATION OF THE SPECTRUM OF HYDROGEN.

perfectly regular curve which has a horizontal asymptote.

In 1885 Balmer showed that this curve is represented *exactly* by the equation—

$$N = \frac{B}{4} - \frac{B}{m_2},$$

B being a constant.

Let us take as an example the spectrum of potassium, in which we have already discovered doublets having a constant interval, which we will call ν.

The close examination of this spectrum shows that its lines are divided by their simple appearance into three categories:—

1. Very brilliant lines which appear even when the metallic vapour is not at a very high temperature, as in a Bunsen flame. They are easily reversible; we will call them the principal series.

The other lines only appear at the highest temperature, in the spectrum of an electric arc charged with potassium vapour, for example.

Here we distinguish:—

2. Fairly wide lines, but with indistinct edges, especially at the red end; they form what Rydberg calls the diffuse series, and Kayser and Runge the first secondary series.

3. Narrow lines of symmetrical appearance, less brilliant than the preceding ones; they form the narrow series, or the second secondary series.

Fig. 3 shows these three series separately; their superposition represents the complete spectrum of potassium, very confused as we know.

In both series the intensities decrease as we approach the ultra-violet; and each series is analogous in its appearance to the series in the hydrogen spectrum.

Let us examine first one of these secondary series; the first, for example. It is formed of doublets all having the constant interval, ν. Therefore it is sufficient to consider one line only of each pair. By representing the frequencies of these lines by plotting analogous to that done for hydrogen, we obtain a curve of the same form with a horizontal asymptote corresponding to the limit of the series (Fig. 4, curve s_1).

This curve is not only analogous to that of hydrogen, but it is almost exactly superposable by two displacements parallel to the axes of the coordinates. Thus we can represent it by an equation of the form—

$$N = A - \frac{B}{(m+\mu)_2}.$$

A, B, and μ are constants, and B has practically the same value as in Balmer's formula. This generalisation of Balmer's formula is due to Rydberg.

If we had taken the second component of each pair of lines we should evidently have found the same curve, dis

* *Revue Générale des Sciences*, Year XIV., No. 5, March 15, 1903.

placed vertically by the amount v; the constant A would simply be changed to A+v. This curve has not been placed in the figure, in order to avoid too great complications. It is deduced from s_1 by an upward displacement of 0·3 m.m.

The second secondary series is also formed of doublets with the constant interval v. It again will be represented by two curves, of which one is the curve s_2 in Fig. 4. We pass from the two curves of the first series to those of the second series by a simple horizontal displacement. The asymptotes are not changed. *The two secondary series have the same limits.*

Finally, we come to the principal series. It is composed of doublets, but only the first of these has the interval v. The others become more and more narrow as we advance towards the small wave-lengths, and their interval tends towards zero.* By using once more the same method of graphic representation, we shall get two more curves. These two curves are superposable by a simple horizontal movement; they have the same asymptote, which means also that the interval of the doublets tends towards zero. We have only shown one of these curves in Fig. 4 (curve P). The other can be made by a simple horizontal displacement of 0·02 m.m. These two curves of the principal series are again almost superposable on those representing the secondary series.

We can see that a single curve displaced successively by suitable amounts in both directions represents the whole of the three series of doublets. Still this superposition of curves is not perfectly exact; while in the case of hydrogen Balmer's formula seems to be absolute, in the case of the metals that of Rydberg is only approximate. Kayser and Runge have given more exact formulæ with a larger number of constants. These are but empirical formulæ. Still the very closely approximate representation of all the series by one single curve is none the less very remarkable.

The other alkaline metals give entirely analogous results, and it is very interesting to compare these spectra with each other. We have already seen that the constant v increases as the square of the atomic weight. If we compare the *limits* of the different series, we find that they approach the red as the atomic weights increase. This is true both for the limit of the principal series and for the limit of the secondary series, as shown by Fig. 5.

Thus we find confirmed what was announced more than twenty-five years ago by M. Lecoq de Boisbaudran, that the spectra are displaced towards the red end as the atomic weights increase, as if the greater mass of the atoms caused their movements to be slower.

Other natural families of metals also have regular and analogous spectra; their structure is similar to that of the spectra of the alkaline metals, but the principal series is at fault, or at least it is no longer represented except by a single known element. The doublets are replaced by triplets in the case of the divalent metals. Thus we have only two series formed of identical groups (doublets or triplets), which is indeed the character of the secondary series. As for the alkaline metals, the limits of these two series are the same. In one natural family of metals these limits move towards the red end as the atomic weights increase, and at the same time the doublets or triplets become wider.

The representation of all these series by a single form

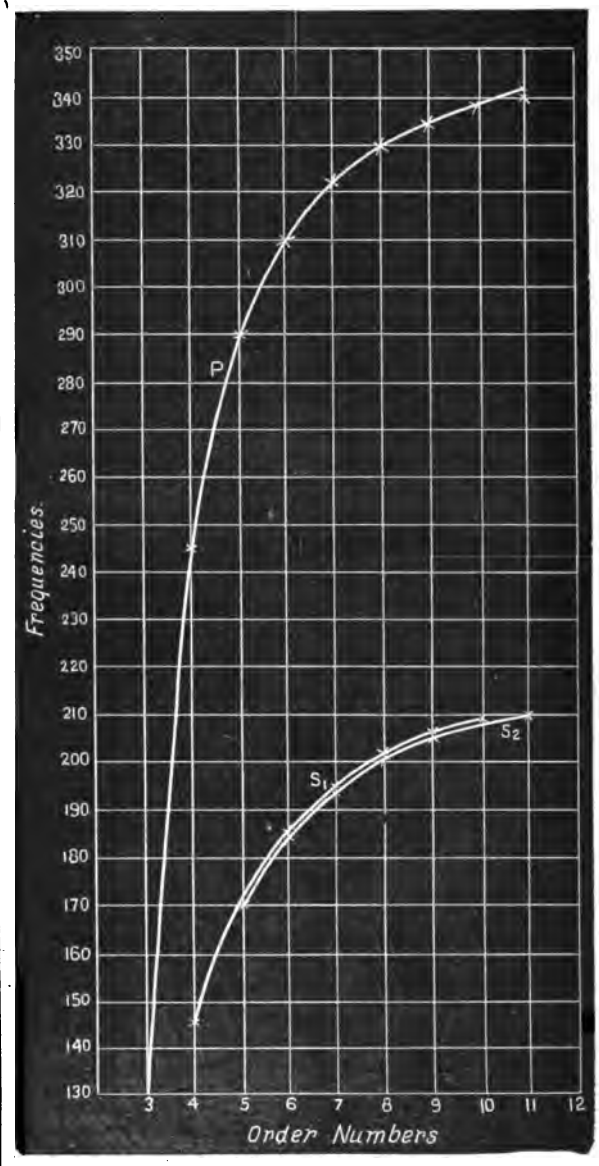


FIG. 4.—GRAPHIC REPRESENTATION OF THE SPECTRUM OF POTASSIUM.

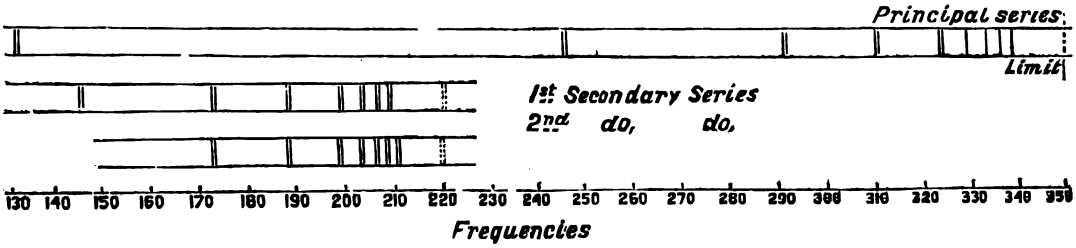


FIG. 3.—SPECTRUM OF POTASSIUM.

* In Fig. 3, we have only been able to show the first doublet of the principal series as a double line. For the others, the two components become confused on the scale to which the drawing is made.

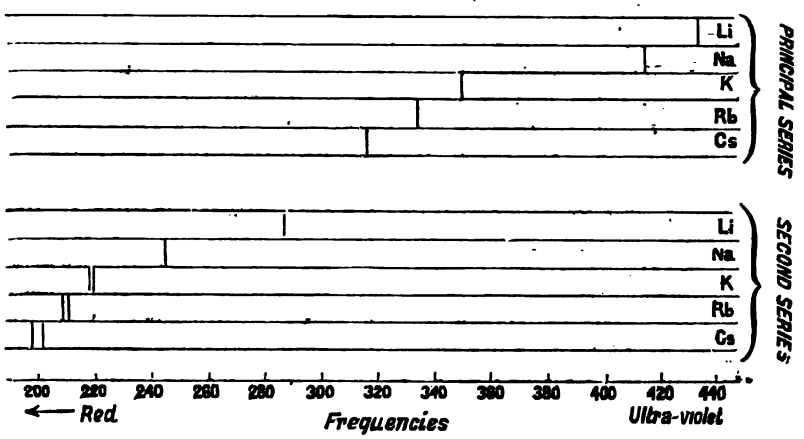


FIG. 5.—LIMITS OF THE SERIES OF ALKALINE METALS.

of curve, more or less displaced parallel to the axes of the coordinates, is one of the most remarkable facts. If we put on one side the position of this curve, and deal only with its shape, which alone remains practically invariable, we observe that it is characterised by the single constant B. It is difficult to get rid of the idea that we have here one of the important constants of nature, since, in spite of slight variations, it characterises not only the properties of a body or of a natural family of bodies, but also those of very diverse simple bodies. It appears to represent a property of matter, of which the simple significance escapes us for the present.

(To be continued).

SOME CELLULOSIC CONSTITUENTS OF ORANGE-PEEL.

By H. STANLEY.

CROSS and BEVAN ("Cellulose," p. 236, 1895 ed.) say:—"The cellular tissue of the plant being regarded as the seat of essential vital operations, . . . whereas the cuticular tissues are mainly concerned in closing off and protecting the tissues beneath from the unregulated action of water and air." And again:—"They (the tissues) are largely depleted of organic nitrogenous matter, upon which vitality depends, and have ceased to live in the full sense of the term, but, on the other hand, are known by casual observation to live in the sense opposed to decay." The "death" is accompanied by condensation processes, with increase of carbon percentage at expense of oxygen and hydrogen.

The results of elementary analysis of the peel are given below. For this purpose the peel was divided into its two main layers; the outer one of the typical orange colour, and the inner one white and of softer texture.

(*Note.*—Unless otherwise stated, the whole thickness of the peel is to be understood, and in all cases dried at 100—105° C.).

Inner Layer.—0·1649 grm. gave 0·2945 grm. CO_2, 0·0860 grm. H_2O, and left 0·0047 grm. white ash. Hence (ash free), C = 50·44 per cent, H = 5·96 per cent, O = 43·60 per cent. The peel contains no nitrogen. The ash preserves to some extent the skeleton of the original fragments, and amounts to 2·95 per cent. The above composition corresponds closely to the formula $C_{34}H_{48}O_{22}$, which, curiously enough, is given to oak wood by W. A. Miller on the results of a similar analysis.

Outer Layer.—The results may here be vitiated by the presence of traces of essential oils not removed by drying. It was expected that this layer would have had the higher carbon percentage, which, however, is not apparently the case. 0·1648 grm. gave 0·2703 grm. CO_2, 0·0946 grm. H_2O, and left 0·0046 grm. white ash. Hence (ash free), C = 45·78 per cent, H = 6·37 per cent, O = 47·85 per cent, ash = 2·84 per cent. The proportion of carbon is in both cases higher than that required by the formula $C_6H_{10}O_5$ (C = 44·2, H = 6·3, O = 49·5).

Action of Acids.

Hydrochloric Acid.—This speedily causes blackening and disintegration, even at a moderate temperature and dilute (1·06 sp. gr.); on distillation furfural is obtained. The general method of Tollens for detection of hexa-carbohydrates by the production of levulinic acid was tried, but with negative results; the products of the reaction either after prolonged exposure to acid of 1·1 sp. gr. or on boiling, gave no colouration with the resorcinol reagent.

Sulphuric Acid.—The action here takes an entirely different course. On boiling the peel with the dilute acid, it is very slowly disintegrated, and a brown solution is obtained. On cooling, a slight flocculent precipitate appeared, the quantity of which was increased by addition of alcohol, and still further increased in alkaline solution. On addition of alkali (NaOH), a marked deepening in the colour of the solution takes place, and the gelatinous precipitate is orange coloured, whereas in acid solution it is colourless. The reaction was examined quantitatively, with regard to cupric reducing power, by the use of Fehling's solution. The results are given as per cent of glucose on the original weight of the dried peel.

Time of boiling.	Weight of peel.	Amount of acid.	Strength of acid.	Glucose.
	Grms.	C.c.	Per cent.	Per cent.
Five minutes	2	30	6·5	14·8
Fifteen minutes	2	30	6·5	17·2
Fifteen minutes	2	60	3·2	19 3
Fifteen minutes	3	80	3·2	20·1
Thirty minutes	8	400	2·0	23·7
Fifteen hours (ordinary temperature)	2	30	6·5	12·9
Fifteen hours (ordinary temperature)	5	100	13·0	20·0

The limit approximates to 20 per cent. The solutions obtained were without action on polarised light both before and after removal of the gelatinous precipitates The latter appeared at first to be of the nature of dextrin, but the following characteristics point to a different conclusion:—They are slightly soluble in water; their solutions are optically inactive and give no colouration with

iodine; they do not unite with phenylhydrazine (acetate), and do not reduce Fehling's solution. All attempts to crystallise out a sugar from the products of hydrolysis failed, but a slight yield of an osazone (?) was obtained, m. p. 161—162°.

Nitric Acid.—The dilute acid (1·14 sp. gr.), by prolonged action at ordinary temperatures, produces slight disintegration; the peel becomes almost colourless and the solution deep brown, whilst a yellow gelatinous precipitate, similar to the one mentioned above, separates out. The solution was filtered from undissolved matter, and the filtrate examined qualitatively; no mucic acid and but traces of saccharic acid were present, but oxalic acid appeared in some quantity. Hexoses are therefore not present in appreciable amount.

Furfural Estimation.

The dried peel was distilled with HCl (1·06 sp. gr.) and the furfural collected and weighed as hydrazone in the usual manner. The first few cubic centimetres of distillate contained a small amount of a yellow oil, which was separated.

5 grms. gave 0·681 grm. hydrazone = 7·3 per cent.
4 „ „ 0·528 „ „ = 7·1 per cent.

The inner and outer layers were examined separately; the yellow oil being found to come exclusively from the outer layer.

4 grms. inner layer gave 0·580 grm. hydrazone = 7·8 per cent.

4 grms. outer layer gave 0·575 grm. hydrazone = 6·9 per cent.

An orange which had been kept for (at least) thirty years, and allowed to shrivel up, and which weighed but 14 grms. (about one-tenth of its original weight, probably), was broken up, and gave the following numbers:—

3 grms. gave 0·450 grm. hydrazone = 8·0 per cent.
3 „ „ 0·455 „ „ = 8·1 „

Here an increase of about 0·8 per cent is noted, and points to slightly increased lignification (not necessarily so, however, as the furfural in some cases decreases with age).

Cellulose Estimation.

Chlorination Method (*Cross and Bevan*).—The peel was boiled with alkali and exposed to chlorine, followed by treatment with dilute sodium sulphite; the addition of the latter caused a not very marked red colouration, which disappeared on boiling. The almost white residue was washed with sulphurous acid, and finally with water, dried, and weighed.

5 grms. (1 per cent soda, fifteen minutes) gave 1·10 grms. residue = 22·0 per cent.

5 grms. (1 per cent soda, thirty minutes) gave 1·02 grms. residue = 20·4 per cent.

Nitric Acid Method.—The loss caused by the action of the dilute acid is considerably less than that caused by the chlorination process (preceded by alkaline treatment). The reverse is usually the case with compound celluloses, the acid attacking both the ligno-cellulose and the less resistant or β-variety of cellulose.

5 grms., heated at 60—70° with acid (1·14 sp. gr.), washed, and dried, gave a residue preserving to some extent the form of the original, and of a pale yellow colour, and amounted to 2·74 grms. = 54·8 per cent.

5 grms. at 60—80°, for a longer period, gave 2·42 grms. residue = 48·4 per cent.

Schulze's Process.—4 grms., treated with 100 c.c. HNO_3 (1·10 sp. gr.) containing 0·3 grm. potassium chlorate for six days at ordinary temperatures, gave 2·33 grms. residue = 58·2 per cent.

4 grms., similarly treated for twenty days, gave 2·15 grms. residue = 53·7 per cent.

It was noticed that the outer layer of the peel went quite green after about one day, and after about three days the whole went to a brown jelly-like mass, which probably retarded the action; this might perhaps be overcome by using a greater volume of acid.

Alkaline Hydrolysis.

Fifteen grms. of the peel were boiled for half-an-hour with 1 per cent soda, and a deep brown solution was obtained. The residue was collected on a cloth filter, washed, squeezed, and dried; it amounted to 5·05 grms., = 33·6 per cent. 4 grms. of this gave 0·504 grm. hydrazone (when distilled with hydrochloric acid), which corresponds to 6·8 per cent of furfural. The action of the alkali, then, is for the most part progressive dissolution, the inner layer yielding to the action rather more readily than the tougher outer layer.

The solution contained no remainder of oil removable by steam distillation, and gave no precipitate with alcohol either before or after acidifying. Evaporated down on the water-bath, it left an almost black tarry residue.

Dyeing Properties.

A characteristic feature of lignocelluloses is their property of "fixing" certain dyes, and more especially the fixing of a blue cyanide from a mixture of solutions of ferric chloride and alkali ferricyanide. 2·65 grms. inner layer of peel, exposed to the action of a mixture of 30 c.c. each of normal solutions of Fe_2Cl_6 and K_3FeCy_6 for forty-eight hours, gave a blue residue which, on washing and drying, weighed 2·90 grms. Increase, 9·4 per cent (on original).

Owing to the author's lack of time, only the results of the above incomplete investigation can at present be recorded.

Merchant Venturers' Technical College,
Bristol, April, 1903.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Wednesday, April 22nd, 1903.

Prof. W. A. TILDEN, D.Sc., F.R.S., President, in the Chair.

MESSRS. C. H. Lockitt, A. J. Webb, and A. H. Scholefield were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Henry James Aubrey, The Cross, Worcester; George Barger, B.A., B.Sc., 50, Guilford Street, W.C.; Charles Drake Bibby, 69, Queen's Road, Twickenham; H. J. W. Brennand, B.A., M.B., Ch.M., 203, Macquarie Street, Sydney; John Christopher Mann, 9, Lambert Street, Hull.

A ballot for the election of Fellows was held, when the following were subsequently declared duly elected:—Henry Guest Adshead; William Lester St. John Alton; Harford Montgomery Atkinson, B.Sc.; Robert Gordon Bibby; George Neville Blackshaw, B.Sc.; Harry Thornton Calvert, B.Sc., Ph.D.; Ben Caudwell, B.A.; Thomas Divine, M.B., C.M.; Arthur William Eastwood, B.A.; John Percy Edgerton; Alan Fletcher; Henry Gough; George Howsam; Alfred Owen Jones; James Stewart Kerr; William Kirkby; John George Collcutt Lock; Arthur Ernest Pitt; Harold Russell Pitt; George Gilbert Pond, Ph.D.; Robert James Porter; Frederick Robertson; Archibald Louis Robinson, B.A.; Fitzroy Owen Jonathan Roose; Ernest William Sawdon, B.Sc.; George Siddle; Montague White Stevens; Henry Edward Stevenson; Giles Hadden Welsford; James Bates Wilkinson, M.D., C.M.; William Francis John Wood, B.Sc.; Edward Chancey Worden.

Of the following papers, those marked * were read:—

*59. "*The Velocity and Mechanism of the Reaction between Potassium Ferricyanide and Potassium Iodide in Neutral Aqueous Solution.*" By F. G. Donnan and R. Le Rossignol.

When potassium iodide and ferricyanide react in neutral aqueous solution, free iodine and potassium ferrocyanide are formed, a definite state of equilibrium being attained. If the free iodine is removed as fast as it is formed by means of sodium thiosulphate solution, the velocity of the direct reaction can be investigated by a method similar to that employed by Harcourt and Esson in their fundamental investigation on the speed of chemical reactions. It was found that the reaction proceeded according to the equation, $-dc/dt = kc_1^2c_2^3$, where c_1 = concentration of ferricyanogen ions, and c_2 = concentration of iodine ions.

The simplest interpretation of this equation is that the primary reaction involves *two* ferricyanogen ions and *three* iodine ions according to the equation—

$$2Fe(CN)_6 + 3I = 2Fe(CN)_6 + I_3.$$

The exponents 2 and 3 of the velocity-equation were determined by separate variations of the ferricyanide and iodide concentrations.

The foregoing account of the mechanism of the reaction does not, however, explain all the experimental results, inasmuch as it gives no explanation of the peculiar fact that although the reaction appears to be bimolecular with respect to the ferricyanogen ions (the concentration of the iodine ions remaining constant), nevertheless, the velocity-coefficient varied with the *initial* concentration of the potassium ferricyanide.

A theory which appears to be capable of giving a quantitative interpretation of all the observed results may be briefly summarised as follows:—

1. The actual reaction is assumed to occur between free *ferric* ions and iodine ions according to the equation,—

$$2Fe^{+++} + 3I^- = 2Fe^{++} + I_3^-.$$

2. The ferric ions in question are assumed to result from an extremely small dissociation of the ferricyanogen ions into ferric and cyanogen ions.

3. The degrees of dissociation of the ferricyanogen and ferrocyanogen ions are assumed to be the same, or practically the same, in solutions containing the same number of equivalents.

Discussion.

Sir William Ramsay said that Mr. Le Rossignol's reaction was the first quinquemolecular reaction which, so far as he knew, had been investigated. It might appear almost incredible that free iron ions should exist in a solution of potassium ferricyanide, but it must be remembered that their concentration was so low that the most delicate tests for iron, namely, the ferrocyanide and ferricyanide reactions, failed to detect them. Mr. Le Rossignol had made an experiment in which he had electrolysed some potassium ferrocyanide, and he had obtained, after a long time, a deposition of metallic iron on the cathode; this, of course, might be due to a secondary reaction, but, so far as it went, it was in corroboration of the theory.

*60. "*A Microscopic Method of Determining Molecular Weights.*" (A preliminary note). By G. Barger.

When two solutions of equal vapour tensions, produced by dissolving two substances in the same solvent, are left in a closed chamber, their volumes will not alter after the chamber has become saturated with the vapour of the solvent. If, however, the vapour tensions are unequal, the solvent will distil from the solution with the greater vapour tension into that with the less.

As the result of a suggestion by Prof. L. Errera, of the botanical laboratory of Brussels University, to the effect that this principle might be used for determining molecular weights, the author has elaborated a method, which apparently differs in certain essential features from those hitherto published, and is briefly as follows:—A standard solution of the substance, the molecular weight of which is to be determined, is compared with a number of standard solutions of a substance of known molecular weight.

Small quantities of the two solutions which are being compared are introduced into a capillary tube, where they form bi-concave, discoid drops, care being taken to use the solutions alternately, so that each drop of one solution is enclosed between two drops of the other. The capillary tube is then sealed at both ends, and the length of each drop is measured under the low power of a microscope with the aid of an eye-piece micrometer. After a few hours, or a day, the measurement is repeated, when, if the vapour tensions of the two solutions are unequal, the drops of one series are found to have increased in size, whilst the others have correspondingly diminished.

By using standard solutions of various strengths, an approximate value for the molecular weight is obtained, the limit of accuracy attained at present being about 10 per cent.

The method will undoubtedly be useful in deciding between multiples of an empirical formula in those cases where ebullioscopic methods are not available.

*61. "*Note on the Spectrum of Pilocarpine Nitrate.*" By W. N. Hartley.

In the current number of the *Transactions*, p. 452, there is a representation of the absorption curve of pilocarpine nitrate as determined by Prof. Dobbie.

In the author's opinion, the curve is that characteristic of nitric acid, and is only indirectly associated with pilocarpine, certainly not belonging, or peculiar to, this alkaloid. On comparing the diagram with the curve common to nitric acid and potassium nitrate (*Trans.*, 1902, lxxxi., 558), the similarity is easily recognised.

Although there are slight differences of detail in the absorption band, these are due to the recorded measurements not being made at exactly the same points or with solutions of the same concentration, and also in part to a slight modification of the nitric acid curve caused by the pilocarpine molecule.

Pilocarpine, if examined by itself or as a salt of any diactinic acid, such as hydrochloric, acetic, or sulphuric acid, will be found to exhibit no absorption band.

This may be predicted both from the fact that pilocarpine nitrate is highly diactinic, and that stronger solutions than are usually employed were necessary in order to obtain clear indications of the absorption band, and also from the composition and structure of the molecule, the evidence for which is adduced by Dr. Jowett. It is probable that pilocarpine and *iso*pilocarpine are not structurally different, although the manner in which they were examined does not justify the conclusion that their absorption curves are identical. It is not safe to draw inferences from solutions of nitrates of the alkaloids, particularly when the bases themselves exert but little absorption. In such cases, a more searching examination might disclose differences between the alkaloids. As the communication neither refers to the existence of the absorption band of nitric acid nor contains evidence of the absorption caused by pilocarpine and of *iso*pilocarpine alone or in combination with a highly diactinic acid, it might be supposed from a study of the paper that pilocarpine was characterised by an absorption band, but this is certainly not the case. It is evident that, as with caffeine, digitaline, and similar alkaloids (*Phil. Trans.*, 1885, clxxvi., 471), the structure of pilocarpine does not confer on the base any peculiar absorptive power or selective absorption.

Discussion.

Dr. Dobbie said that the purpose of Prof. Hartley's note was not to call in question the validity of the conclusion that pilocarpine and *iso*pilocarpine are probably isomerides, which had been based on the comparison of their nitrates, but to point out that no information as to the chemical

structure of these bases could be derived from the fact that concentrated solutions of their nitrates showed a well-marked absorption band.

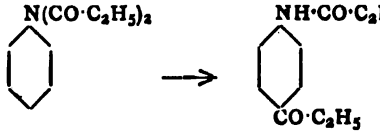
Such bands are usually, in the case of organic compounds, associated with the possession of a benzenoid, pyridine, or similar nucleus, but, inasmuch as nitric acid itself in concentrated solution gives a well-marked absorption band, the presence of a band in the nitrates examined afforded no evidence of the presence of such a nucleus in the alkaloids. The band of pilocarpine, and of *iso*pilocarpine nitrate, occupies the same position, and is very similar to, without being actually identical with, the band of nitric acid. Prof. Hartley regards it as the band of nitric acid modified by the presence of the alkaloid. It is this modification of the band which is of importance in relation to the comparison between pilocarpine and *iso*pilocarpine, instituted in Dr. Jowett's paper. Since the modification is exactly the same in both cases, the conclusion that pilocarpine and *iso*pilocarpine must have the same chemical structure remains unaffected.

In this case, it was necessary to use concentrated solutions of the nitrates for the investigation, because it was found impossible to obtain satisfactory solutions of the free bases.

In the case of alkaloids of high molecular weight, such as berberine, the absorption spectra of dilute solutions of the nitrate are practically the same as those of the chloride, and wholly different from the spectra of nitric acid. Prof. Hartley's caution as to the employment of nitrates in the investigation of chemical structure by the spectroscopic method applies, therefore, more particularly to those highly diatinic substances, which, like pilocarpine, have comparatively low molecular weights.

62. "*Isomeric Change of Dipropionanilide into Propionyl-p-aminopropiophenone.*" By F. D. Chattaway.

Under the influence of various reagents, dipropionanilide, like diacetanilide and dibenzanilide, undergoes transformation into propionyl-*p*-aminopropiophenone:—



Although the *o*-derivative is probably also formed in small amount, only the *p*-derivative can be isolated in quantity. As a catalytic agent, zinc chloride gives the best yield, but hydrogen chloride is also applicable, the transformation being most readily effected by heating propionanilide dissolved in an equivalent amount of propionic anhydride with about one-third its weight of dry powdered zinc chloride for twelve to sixteen hours at 140—150°.

The product, after hydrolysis with alcoholic hydrogen chloride, is rendered alkaline and distilled in steam, the *p*-aminopropiophenone separating from the residual solution in reddish-yellow plates (yield = 50 per cent). The base, which is obtained colourless by crystallisation from alcohol or chloroform, separates in flattened rhombs (m. p. 142°); its acetyl derivative forms colourless, hexagonal prisms (m. p. 175°). Kunckell (*Ber.*, 1900, xxxiii., 2641) describes these compounds as crystallising in yellow needles melting respectively at 140° and 161°.

p-*Aminopropiophenone sulphate*,—

$$(C_2H_5\cdot CO\cdot C_6H_4\cdot NH_2)_2,H_2SO_4,$$

a sparingly soluble salt, forms anhydrous, colourless plates which become red and decompose at 223°; the *platinichloride*, $(C_2H_5\cdot CO\cdot C_6H_4\cdot NH_2)_2,H_2PtCl_6$, forms small, orange-coloured needles.

p-*Acetylchloroaminopropiophenone*,—

$$C_2H_5\cdot CO\cdot C_6H_4\cdot NClAc,$$

colourless plates, m. p. 75°; p-*acetylbromoaminopropiophenone*, short, yellow prisms, m. p. 115°; p-*propionylaminopropiophenone*, $C_2H_5\cdot CO\cdot C_6H_4\cdot NH\cdot CO\cdot C_2H_5$, slender, colourless prisms, m. p. 153°; p-*propionylchloroaminopropiophenone*, $C_2H_5\cdot CO\cdot C_6H_4\cdot NCl\cdot CO\cdot C_2H_5$, colourless plates, m. p. 80°; p-*propionylbromoaminopropiophenone*, pale yellow, elongated plates, m. p. 120°; p-*benzoylaminopropiophenone*, $C_2H_5\cdot CO\cdot C_6H_4\cdot NH\cdot CO\cdot Ph$, thin, colourless, elongated plates, m. p. 190°; p *benzoylchloroaminopropiophenone*, $C_2H_5\cdot CO\cdot C_6H_4\cdot NCl\cdot CO\cdot Ph$, colourless plates, m. p. 70°; p-*benzoylbromoaminopropiophenone*, bright yellow, rhombic plates, m. p. 111°.

When heated quickly, the nitrogen-halogen derivatives all undergo transformation at about 200—230° with much decomposition.

63. "*Note on the Formation of Di- and Hexa-methylammonio-cadmium Chlorides.*" By W. R. Lang.

Dry methylamine and cadmium chloride react at −11°, but not at −80°, to form a white powder, corresponding with the formula $CdCl_2,6CH_3\cdot NH_2$. When heated to 100°, a stable substance is obtained having the composition $CdCl_2,2CH_3\cdot NH_2$, its decomposition is not complete at 300°.

PHYSICAL SOCIETY.

Ordinary Meeting, April 24th, 1903.

Mr. T. H. Blakesley, Vice-President, in the Chair.

Mr. W. B. Croft exhibited the following Elementary Apparatus:—

1. A rhombohedron with each side a rhombus; to show the optic axis of calcite. There is some doubt whether this figure has a distinctive name.

2. Two equal pendulums A and B hanging from an elastic string. An oscillation is given to A; this movement is taken up by B, all of it; and A is left to rest. Then A takes it all back, and the alternation continues. It results from this that if A and B both start with oscillations in planes at right angles, each will give its own movement to the other.

3. Newton's rings with a plate and prism as shown in Preston's "Light." Rings may be seen through both of the free sides of the prism at once; they are oppositely polarised. Another set may be seen by reflexion from one of these sides, red and green, unpolarised.

4. Herschel's Fringes in Fox-Talbot's form with two right-angled prisms. These fringes are at the border between total reflexion and transmission. By turning the apparatus it may be seen that they develop continuously into Newton's rings, with almost perfect achromatism in one portion. Two prisms have been used which are not optically worked. At the position of total reflexion the point of contact is like a piece of soot on silver; to an observer in the line at right angles it seems like a hole cut in black velvet. There appears to be continuous glass, and not the two surfaces which cause the loss of half a wave. The effect does not seem to be easily produced with optically worked surfaces.

5. Brewster's Bands in thick plates. This apparatus is based on the description in Preston's "Light"; but it seems to be better to use a large aperture.

A paper on "*Dimensional Analysis of Physical Quantities and the Correlation of Units*" was read by Mr. A. F. Ravenshear.

The object of this paper is to knit together various divergent views which are current on the subject of dimensions. It is shown that while (1) dimensional analysis and the correlation of units of different kinds can be pursued in one direction until, with completed correlation, we arrive at degrees of undifferentiated quantity, a different procedure may be followed which (2) gives rise to various systems of dimensions descriptive of the physical relationships of the quantities treated. The conditions giving rise to dimensional relations are first set out; and it is

proposed to distinguish the purely quantitative reading of a dimensional formula by enclosing the sign of equality in square brackets thus :—

$$[\text{force}]\ [=]\ [M]\ [L]\ [T^{-2}],$$

and the reading of it as a physical identity or equivalence thus :—

$$[\text{force}] \equiv [M]\ [L]\ [T^{-2}].$$

A criterion for distinguishing quantities which can be regarded as undimensional from those which are essentially dimensional is proposed in the question :—Is the quantity absolutely constant for all substances under all conditions ? The dimensional relation $M = L^3T^{-2}$ derived from the law of gravitation, is then justified and is examined at length. This relation, combined with the demand for the complete correlation of all dynamical units, is shown to require the adoption of the convention—

$$[L]\ [=]\ [T]\ [=]\ [M].$$

This result is interpreted by (1) above. Systems of dimensions are next discussed, with the aid of illustrative tables, and it is shown that by employing different physical laws as bases many different systems may be constructed. By comparison of these systems an index law connecting the dimensions of any physical quantity in different systems becomes manifest, viz., the sum of the indices of L, M, and T is always the same for the same quantity in different systems. The dimensions of magnetic quantity in certain different systems are, for example,—

$$L^3T^{-2},\ ML^{-1}T,\ \varkappa L^3T^{-1},\ \rho k^{-\frac{1}{2}}M^{\frac{1}{2}}L^{\frac{1}{2}},\ \mu^{\frac{1}{2}}M^{\frac{1}{2}}L^{\frac{3}{2}}T^{-1}.$$

It is concluded that the sum of the indices of L, M, and T in k, μ, and other conventionally suppressed quantities must be zero. By reference to the laws of atomic heats and electrolysis, dimensions for temperature and other thermal quantities are found. Excepting as regards suppressed quantities, temperature is found to have the dimensions of E.M.F. The measurement of force by reference to the law of gravitation is shown to rationalise the indices in the dimensions of electrical and magnetic quantities ; and the irrationality of the indices in the conventional systems is explained as due to combining inverse square laws with the simple proportionality of the second law of motion. Finally, it is pointed out that matter, as well as direction, may be distinguished in dimensional formulæ, according to whether it enters as gravitating matter (M_G) mass or inertia (M_I), electrodeposited matter (M_E) or otherwise; and the dimensions of electrical resistance are found in terms of quantities thus distinguished in illustration of (2) above.

Mr. R. J. Sowter read a "*Note on Dimensions of Physical Quantities.*"

Mr. Ravenshear has shown that any physical quantity is expressible in terms of the dynamical quantities L, M, and T, in different ways, but that all the various ways are connected with one another by an index law. One interpretation of this is that the dynamical factors are complete in themselves. They express change-ratios, and have no qualitative significance. μ, k, γ, &c., do not contain dynamical factors, but carry with them the physical qualities or characteristics of the quantities associated with them. Any physical quantity, on this hypothesis, is expressible as $Q = N(D^n)q$, where N is a mere number, (D^n) is a dynamical factor indicating a quantitative measurement process, and q is a quality factor of the nature of Q.

Prof. Everett said the possibility of making two fundamental units suffice instead of three, by taking advantage of the law of gravitational attraction, was nothing new, but was expounded and worked out in some of its applications in ordinary text-books. The proposal to diminish the number of fundamental units by making the unit of length proportional to the unit time, simply amounted to the adoption of a fundamental unit of velocity to take the place of a unit length, and was no simplification. The supposed new law of indices appeared to be simply the well known principle by which information as to physical relations could often be deduced from consideration of dimensions ; by which, for example, it could be shown that the velocity of sound must vary directly as the square root of elasticity and inversely as the square root of density.

Mr. Price referred to the fact that the author had determined the dimensions of mass in terms of length and time from the equation $f = m^2/l^2$, considering G, the Newtonian constant of gravitation, as a quantity without dimensions. He thought that if all suppressed dimensions were properly introduced and proper attention paid to the direction of vector quantities, then the dimensions of a quantity gave an idea of its nature, and quantities having the same dimensions were identical in their natures.

Prof. S. P. Thompson said he had read the paper through, and thought it brought the subject no further forward. There were several statements which were so surprising that it was necessary to give them consideration. For instance, we were asked to believe that a scalar, like mass, was of the same dimensions and nature as a vector, like length, and that both of these were physically the same as time. There is no distinction at all in the paper between scalars and vectors. The author's criterion for an undimensional quantity was a false one, and led to obviously incorrect results. Taking the formula $F = Ma$, he (Prof. Thompson) said that, using the author's criterion, mass had no dimensions. The criterion also made G, the Newtonian constant, an undimensional quantity. Referring to the equation $Q = N(D^n)q$ given in Mr. Sowter's note, he thought that the right-hand side might contain a fourth letter representing a geometrical operator. Mr. Ravenshear in his paper had retained fractional exponents which were meaningless and could not possibly exist.

Mr. Ravenshear said that much of the criticism appeared to him to be based upon misunderstandings of his position and the propositions he had advanced. He did not think that G necessarily had no dimensions. His contention was that, owing to its universal constancy, to give it dimensions was not logically compulsory, and therefore it was optional to work out the consequences of both alternatives. He would have preferred that Prof. Thompson had criticised his criterion using Joule's equivalent, the example dealt with in his paper. The example used by Prof. Thompson did not satisfy the criterion, since masses might have any magnitude. He had not advocated the retention of irrational indices, but had put in a plea for two or three systems in which all the indices were integral. Prof. Everett had discussed the matter as though a new system of units was being proposed for practical adoption. Mr. Ravenshear said that, on the contrary, his object was merely the logical analysis of the principles underlying the use of units. He had not proposed to use velocity in place of length or time, but contended that a permanent motion furnished in a single standard two units from which all other dynamical units could in principle be derived.

Mr. Sowter said that Mr. Ravenshear had shown an alternative method of rationalising irrational expressions. Referring to Prof. Thompson's observation that the equation $Q = N(D^n)q$ required a further term representing a geometrical operator, he pointed out that if different directions are accounted for by symbols, these take their places in the dynamical or measuring factors (D^n), so that any physical quantity need only be expressed by the three factors set forth. As regards Prof. Everett's remark on the index law, he was aware of the application of dimensional analysis to the solution of certain physical problems, but he was not aware that the index law had been formulated and the deductions based upon it dealt with previously.

ROYAL INSTITUTION.

Annual Meeting, May 1st, 1903.

Sir James Crichton-Browne, Treasurer and Vice-President, in the Chair.

The Annual Report of the Committee of Visitors for the year 1902, testifying to the continued prosperity and efficient management of the Institution, was read and adopted, and the Report on the Davy-Faraday Research Laboratory of the Royal Institution, which accompanied it, was also read.

Sixty-two new Members were elected in 1902. Sixty-three Lectures and twenty Evening Discourses were delivered in 1902. The Books and Pamphlets presented in 1902 amounted to about 211 volumes, making, with 683 volumes (including Periodicals bound) purchased by the Managers, a total of 894 volumes added to the Library in the year.

Thanks were voted to the President, Treasurer, and the Honorary Secretary, to the Committees of Managers and Visitors, and to the Professors, for their valuable services to the Institution during the past year.

The following gentlemen were unanimously elected as Officers for the ensuing year:—

President—The Duke of Northumberland.

Treasurer—Sir James Crichton-Browne.

Secretary—Sir William Crookes.

Managers—Mr. Henry E. Armstrong, Sir Benjamin Baker, Mr. Shelford Bidwell, Sir Alexander Binnie, Sir Frederick Bramwell, Bart., The Hon. Sir Henry Burton Buckley, The Right Hon. The Earl of Halsbury, Dr. Donald William Charles Hood, The Right Hon. Lord Lister, Mr. George Matthey, Mr. Edward Pollock, Sir Owen Roberts, Sir Thomas Henry Sanderson, Sir Felix Semon, and Sir John Isaac Thornycroft.

Visitors—Mr. John B. Broün-Morison, Mr. Horace T. Brown, Mr. Frank Clowes, Dr. James Mackenzie Davidson, Mr. Frederick William Fison, Mr. Francis Fox, Mr. Francis Gaskell, Dr. James Dundas Grant, Lord Greenock, Mr. James E. Horne, Mr. Maures Horner, Mr. Wilson Noble, Mr. Arthur Rigg, Dr. George Johnstone Stoney, and Mr. George Philip Willoughby.

NOTICES OF BOOKS.

Examination of the Atmosphere of the Central London Railway. Reports by the Chemist and the Medical Officer of Health to the London County Council, to which is Appended a Report by Dr. Andrewes. London: P. S. King and Son. 1903. Pp. 21.

From the point of view of the travelling public, it is very satisfactory to know that there is so little fault to be found with the quality of the air in the Central London Railway, better known as the "Twopenny Tube."

The chemist to the London County Council, Dr. Frank Clowes, expresses the opinion that samples of air taken at any point on the railway should not contain more than 8 volumes of carbon dioxide in 10,000 volumes of the air; that is, not more than twice the amount which is generally found in the air of the street. Of the samples collected, about 22 per cent contained less than this amount, and 34 per cent contained less than two and a-half times as much carbonic acid as that found in the outside air.

Contrary to what would be expected, the air of the smoking carriages contained less carbonic acid than those in which smoking does not take place.

We see in Table VI., giving the maximum and minimum amounts of carbonic acid in samples of the air collected in different places on the Tube Railway, that the highest amount, viz., 15·2 per 10,000, was found in the lifts; this is not astonishing considering the manner in which the lifts are generally packed. In the carriages the figures varied from 14·7 to 9·6 per 10,000, figures which compare very favourably with the air found in *empty carriages* on the City and South London Railway, the Metropolitan, and District Railways. In the case of the Metropolitan Railway the air in an empty carriage between Gower Street and Baker Street contained as much as 28·8 parts of carbonic acid per 10,000 parts of air.

It must be remembered, however, that the carbonic acid in the Tube Railway is due entirely to respiration, and for this reason may be regarded as being more unwholesome than that resulting from the combustion of fuel, on account of the bacteria which may be present.

Let us turn, therefore, to the results obtained by Dr. Andrewes from his bacteriological examination of the Tube air.

The plan adopted by Dr. Andrewes was to take twelve samples of air from different parts of the railway and compare them with twelve samples taken at the same times in the fresh air outside. The details of the method adopted were all carefully worked out, and every care taken to ensure accuracy.

Owing to the fact that a large majority of the organisms present in the air do not grow at the body temperature, and that pathogenic microbes grow more rapidly at this temperature than at that of an ordinary room, the totals are taken from the gelatin plates incubated at 20° C., while duplicate plate cultivations in agar were incubated at 37° C. The highest averages are found in the railway carriages, closely followed by the platforms and lifts; the figures are 63·6, 60, and 56 microbes per 5 litres respectively. In the passages and tunnels the numbers were 20 and 17. The highest actual figures found were on a platform and in a carriage, viz., 112 and 103. The highest number found in the outside air was 93, the lowest being found in the quiet parts of Hyde Park and Kensington Gardens, where the number of micro-organisms sank to 2 in 5 litres of air.

Taking the average of all the observations we find that the outside air contained 33·9 microbes, and the Tube air 44·1. This is only a small difference, and is unduly accentuated, we think, by the fact that several of the samples of the outside air were taken from places practically uninhabited, and by no means representing the ordinary conditions of London life. But in spite of this slight bias against the Tube, the results show clearly that there is no cause for alarm or even for uneasiness; no pathogenic species were found, and Dr. Andrewes states that his attention was so constantly directed to their discovery that he feels tolerably sure that none were overlooked in the 600 or so colonies examined.

The absence of streptococci was a surprise in view of their abundance in the human mouth; this fact speaks powerfully in favour of the rule on the Tube, "Please do not Spit." Altogether, the air of the Tube Railway does not compare unfavourably with that known to exist in inhabited rooms generally, and is probably better than the air in most churches, theatres, and large shops.

Yearly Reports of the Royal Higher College of Agriculture of Portici. ("Annali della Regia Scuola Superiore di Agricoltura di Portici"). Second Series, Vol. IV. Continuation of the Annual Reports of the Royal College from 1875-1898. Portici: Premiato Stab. Tipografico Vesuviano. 1903.

The papers included in this volume are principally concerned with agriculture and arboreal matters; there are a few, however, which are more of a chemical nature; among these we may mention one on "The Analytical Examination of the Products of Recent Eruptions of Vesuvius (1891-4 and 1895-99)," by Eugenio Casoria. The analysis of these materials shows the presence of molybdenum, bismuth, cobalt, zinc, and copper, besides the more common constituents, such as lime, potash, silica, iron, and alumina.

There is also another much longer paper, covering 196 pages, by the same author, in which are given the results of many analyses of mineralised waters in the valleys of the Sarno, the Irno, the Scraio near Vico Equeuse, and others from the neighbourhoods of Vesuvius, Flegrea, and Roccamonfina. Two other papers by Ernesto Monaco are entitled "A Cadmiferous Blende from Mount Somma," and "An Arsenical Sulphide from Pozzuoli."

Exercises in Practical Chemistry and Physics. By J. Young, A.R.C.S., F.C.S., Instructor in Chemistry, Royal Military Academy, Woolwich, Second Edition. Revised and Enlarged. Woolwich: F. J. Cattermole. 1903. Pp. 103.

This is essentially a laboratory guide, and will be of great assistance to beginners in practical chemistry. The author gives first the reactions of the commoner metals in their regular group order, then the reactions of the acids; this is followed by analytical tables and exercises in simple qualitative and quantitative work.

There are a few technical exercises adapted to the special case of the college at which Mr. Young is the instructor, such as making gun-cotton and picric acid. There is a thorough "business" appearance about the book, the instructions are concise, and no words are wasted in long descriptions.

Acetylene, its Theory and Applications. ("L'Acétylene, Théorie, Applications"). By Marie Auguste Morel, Engineer. Illustrated. Paris: Gauthier-Villars. 1903. Pp. 169.

The acetylene industry may be fairly claimed by English chemists as due to the work of two of their distinguished predecessors, the brothers Davy. Acetylene was discovered by Edmund Davy, Professor at the Royal Society of Dublin, in March, 1836, and the electric furnace, by means of which carbide of calcium is now manufactured on the large scale, is the outcome of the discovery of the voltaic arc by Sir Humphry Davy in 1813.

It was while preparing potassium (also discovered by Sir Humphry Davy) from carbon and carbonate of potassium that Edmund Davy obtained a black residue which when treated with water gave off a hydrocarbon, which was nothing else than acetylene; however, this name was not given to it until the year 1862, when M. Berthelot re-discovered carbide of potassium, and by its means produced acetylene.

In the following years many other chemists occupied themselves with the study of acetylene, and in 1877 it was liquefied by Cailletet; it was solidified by Willson and Suckert in 1895, and in the same year the practical method of preparing this gas was introduced by the decomposition of carbide of calcium by water.

It was at the end of 1892 that M. Moissan described the new electric furnace he had devised in conjunction with M. Violle, in which a temperature of 2500—3000° was obtained with ease; at this latter temperature carbon reduces oxide of calcium rapidly, and the metal unites with the carbon of the electrodes, forming carbide of calcium, liquid at a red heat, and easily collected.

There have been many works written on acetylene and its production, but the one now before us differs from most of its predecessors in that it treats the subject entirely from the scientific point of view, whereas many other authors have obviously had "an axe to grind."

The first two chapters of this volume deal in a general manner with the metallic hydrocarbides. The history, preparation, properties, and applications of carbide of calcium form the subject of Chapter III.

The two following chapters deal with the physical, chemical, and other properties of acetylene, and its numerous applications are passed in review in Chapter VI. Finally, in Chapter VII. the author describes his own researches on apparatus for the production of acetylene gas.

In the theoretical portion of the book the author has described the work done by the large number of scientific men, both French and those belonging to other nations, who have done so much in this connection, and in the practical part he has confined himself to the applications relevant to science, and describes only those apparatus which agree with the conclusions established from theory.

The book is well written, and is worth binding, though it is not provided with an index.

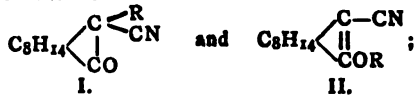
CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 13, March 30, 1903.

Affinity at Low Temperatures. Reaction of Liquid Fluorine at −187°.—H. Moissan and J. Dewar.—The affinity of liquid fluorine at a temperature of −187° is powerful enough to ignite sulphur, selenium, phosphorus, and arsenic without the aid of any external energy. It violently decomposes calcium oxide, and with anthracene forms an explosive mixture. Such experiments show that, at very low temperature, the force of affinity acts strongly in reactions as energetic as those between fluorine and certain simple or compound bodies.

Alcoyl and Acylcyanocamphors and Alcoylcamphocarbonic Ethers. Influence of the Double Liaison of the Radicle containing the Asymmetric Carbon on the Rotatory Power of the Molecule.—A. Haller.—In order to examine the influence of the double liaisons on the rotatory power of certain cyclic molecules, the author prepares a number of derivatives of cyanocamphor and submits them to a series of new investigations, by which it is proved that, during their preparation, there are formed the two varieties—



I. II.

the enolic form (II.) always being present in the largest quantity.

Action of Hydrogen on Arsenic Sulphides in presence of Antimony, and on Antimony Trisulphide in presence of Arsenic.—H. Pélabon.—The author finds that—(1) Antimony completely displaces the arsenic in arsenic sulphide if the two bodies are liquid; (2) hydrogen gas, when heated in presence of antimony sulphide and a mixture of arsenic and antimony, forms sulphuretted hydrogen (the proportion of this latter gas increasing with the amount of arsenic in the preceding mixture); (3) the effect of the arsenic is to decidedly increase the value of the proportion R (the ratio between the partial pressure of the sulphuretted hydrogen and the total pressure of the gaseous mixture); at 625° with pure antimony sulphide and excess of antimony it is the constant number 0·568.

Pyrophosphorous Acid.—V. Auger.—The author succeeds in preparing pyrophosphoric acid by passing the vapour of PCl_3, in presence of a current of CO_2, into the liquid formed by the action of water on excess of PCl_3. The crystals, when purified, are in the form of colourless needles fusing at 38°.

Action of Phosgene on Mixed Organo-magnesium Compounds.—V. Grignard.—The commercial toluenic solution of phosgene, containing 20 per cent of the latter substance, was used to react on organo-magnesium compounds, giving rise to a more or less abundant crystalline precipitate. Theoretically, the reaction can take place in two different ways:—(1) To produce a symmetric

ketone by the reaction of two molecules of the organo-magnesium compound on a molecule of phosgene:— $COCl_2+2RMgX=R—CO—R+2MgXCl$; or, similarly, $ClCOCl+2RMgX=ClC(R)(OMgX)+MgXCl$. By treating the resulting products with water in the second case, the unstable $R_2C(OH)Cl$ is obtained, which loses HCl, giving R_2CO. (2) By the action of three molecules of the organo-magnesium compound on one molecule of phosgene a symmetric tertiary alcohol is obtained:— $COCl_2+3RMgX=R_2C(OMgX)+2RMgXCl$.

New Researches on the Decomposition of Organic Acids.—MM. Œchsner de Coninck and Raynaud.—The authors continue their researches on the decomposition of the fatty and aromatic acids by treating them at a high temperature with a large excess of sulphuric acid or glycerin. By this means they have more or less verified the stability of the isomeric aromatic acids, and have been able to discover which acids begin to lose carbonic acid at a temperature of about 300°.

Constitution of Nitro-cellulose.—Léo Vignon.—Nitro-celluloses, when reduced by ferrous chloride in acid solution, give rise to oxycellulose. This fact differentiates cellulose decidedly from mannite and from other poly-atomic alcohols which the author has examined from the point of view of nitration.

MISCELLANEOUS.

Royal Institution.—On Saturday next, May 9th, at 3 o'clock, Mr. Hamish MacCunn commences a course of three lectures at the Royal Institution on "Music" (with Musical Illustrations); on Tuesday, May 12th, at 5 o'clock, Prof. G. H. Darwin delivers the first of two lectures on "The Astronomical Influence of the Tides"; and on Thursday, May 14th, Prof. S. H. Vines begins a course of two lectures on "Proteid-Digestion in Plants." The Friday Evening Discourse on May 15th will be delivered by Dr. D. H. Scott on the "Origin of Seed-Bearing Plants," and on May 22nd by Dr. J. A. H. Murray on "Dictionaries."

Royal Institution.—A General Monthly Meeting of the Members of the Royal Institution was held on the 4th inst., Sir James Crichton-Browne, Treasurer and Vice-President, in the Chair. The Chairman announced that His Grace the President had nominated the following Vice-Presidents for the ensuing year:—Sir Benjamin Baker, Sir Frederick Bramwell, Bart., the Right Hon. the Earl of Halsbury, Dr. D. W. C. Hood, the Right Hon. Lord Lister, Mr. George Matthey, Sir James Crichton-Browne (Treasurer), and Sir William Crookes (Honorary Secretary). The special thanks of the Members were returned to Mrs. Frank Lawson for her donation of £50 to the Fund for the Promotion of Experimental Research at Low Temperatures. The following were elected members:—Mr. W. M. Bird, Sir Edward H. Carbutt, Bart, J.P., Mr. C. Craies, Mr. H. M. Duncan, Dr. A. P. Gould, Mr. J. C. Hawkshaw, Mr. J. G. Hossack, Captain H. A. Johnstone, Lieut.-Colonel W. R. Murphy, Major George J. W. Noble, Mrs. G. J. W. Noble, Mr. H. A. Owen, Mr. C. J. Radermacher, Mr. J. B. L. Stilwell, Mr. R. G. Watt, and A. C. Wombwell.

Memorial to the late Sir Henry Bessemer.—We are requested to announce that a representative Committee has been formed for the purpose of raising a Memorial to the late Sir Henry Bessemer. The phenomenal industrial development of the world in recent years is largely due to the metallurgical process which bears the name of Bessemer, and it has long been felt that his life's work should be suitably commemorated in the centre of the British Empire. The objects of the Memorial are as follows:—

1. The erection (and if necessary the endowment) of Metallurgical Teaching and Research Works in connection with the University of London, equipped for the testing of Ores and Metallurgical Products by modern methods, and for the investigation of new methods and processes.
2. The foundation of International Scholarships for post-graduate courses in practical work in connection with proposals now under the consideration of the Board of Education.

The Committee includes leading representatives of the Metallurgical, Engineering, and Mining Industries and Professions, and of Education Authorities. A Meeting to inaugurate the Fund will be held at the Mansion House on Monday, June 29th next, particulars of which will be published later. All communications should be addressed to the Secretary, Bessemer Memorial Fund, Salisbury House, London, E.C.

"The Etiology of Typhoid Fever."—His Majesty the King has been graciously pleased to accept from Prof. Corfield, M.D., of University College, Consulting Sanitary Adviser to His Majesty's Office of Works, a copy of the Milroy Lectures on "The Etiology of Typhoid Fever," delivered by him before the Royal College of Physicians last year, by special request of the Council of the College; in one of which lectures Dr. Corfield states his opinion that the attack of typhoid fever from which His Majesty suffered in 1871, when Prince of Wales, was not due to any sanitary defects in Londesborough Lodge, Scarborough, the house in which he was staying, and the sanitary condition of which was described by Dr. Corfield in a letter published in *The Times* of January 23rd, 1872, but was no doubt due to contaminated food or drink partaken of by His Royal Highness, the gentlemen of the party, and some of the men servants, away from the house, perhaps at a shooting luncheon, as Her Royal Highness the Princess of Wales, the ladies of the party, and all the female servants escaped infection; the disease, in fact, entirely spared those who were most in the house, and only attacked those who were most away from it, and some of whom did not even sleep there.

A Dust-Arresting Respirator.—The Council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a Prize of a Gold Medal or £20, for the best Dust-Arresting Respirator for use in dusty processes and in dangerous trades. The Council are well aware that for many years past the necessity for such an apparatus has been recognised. As far back as 1822 the Society awarded its Gold Medal to Mr. J. H. Abraham, of Sheffield, for a Magnetic Guard to protect persons employed in dry grinding. The apparatus described in the Society's *Transactions* (1822, vol. xl., p. 135) includes a Respirator to cover the mouth and nose. This Respirator was fitted with magnets, for the purpose of arresting the fine particles of steel thrown off in the process of pointing needles, and in other processes of dry grinding. Although the invention was greatly appreciated at the time, it appears never to have come into practical use, the main objection to it having been, it is believed, raised by the workpeople themselves, who feared that the lessened risk attached to their employment would lower their wages. Similar considerations have, it is believed, stood in the way of the introduction of various appliances intended to limit the risks associated with all trades in which the workpeople breathe a dusty atmosphere. The Council, however, think that such considerations are likely to have less weight at the present time, and they hope that the offer of a prize may draw the attention of inventors to the matter, so that it may result in the production of some suitable piece of apparatus, despite the difficulties with which the solution of the problem is surrounded. The apparatus will be required to fulfil the following conditions:—

1. It must be light and simple in construction:—
2. It should be inexpensive, so as to admit of frequent renewal of the filtering medium or of the Respirator as a whole; or alternatively it should be of such construction that it can be readily cleaned.
3. It should allow no air to enter by the nostrils or mouth except through the filtering medium.
4. It should not permit expired air to be re-breathed.
5. The filtering medium, though it should be effective in arresting dust particles, should not offer such resistance as to impede respiration when worn for some hours under the actual conditions of work.
6. It is desirable that it should be as little unsightly as possible.

It should be noted that the prize is offered for a Respirator intended merely to arrest dust, and not for a chemical Respirator designed to arrest poisonous fumes. The applications of such chemical Respirators are more limited, and there are special requirements connected with them. The Council have, therefore, preferred to limit the range of their present offer to the simpler and more important cases of dust, either dust of all kinds, or of some special character, *e.g.*, iron or steel. Inventors intending to compete should send in specimens of their inventions not later than December 31st, 1903, to the Secretary of the Society of Arts, John Street, Adelphi, London, W.C. Such specimens must be accompanied by full descriptions, and in cases in which the apparatus has been put into actual use, the experience of such use should be given. Competitors intending to patent their inventions should be careful to obtain protection, as the Council of the Society cannot undertake any responsibility as regards the secrecy of the whole, or of any part, of an invention submitted to them. The Prize will be awarded on the report of judges appointed by the Council. The competition is not limited to British subjects. The Council reserve to themselves the right of withholding the Prize, of extending the time for sending in, or of awarding a smaller Prize or smaller Prizes.—Henry Trueman Wood, *Secretary*.

The C-acylised Derivatives of the Acetylacetic Ethers.—L. Bouveault and A. Bongert.—The authors describe the preparation and properties of a number of these derivatives, such as the C-butyrylacetylacetate of methyl, the C-isovalerylacetylacetate of methyl, the C-caproylacetylacetate of methyl, and the corresponding ethylic derivatives.—*Bull. Soc. Chim.*, xxvii., No. 20.

The Hydrates $R(OH)_2$.—F. F. Sélivanof.—The author, having observed that freshly precipitated HgO is soluble in a solution of acetamide, but that it is no longer so some time after precipitation, was induced to examine the different metallic hydrates from the point of view of their solubiliiy. The peculiarity shown by HgO may be explained by admitting that $Hg(OH)_2$ is formed first, and that this substance is then transformed into the insoluble HgO; but there are numerous hydrates insoluble in water, but which dissolve in solutions of sugar, glycerin, &c, provided they are in contact with these solutions at the moment of their precipitation; for this reaction it is much more difficult to find an explanation. $Cu(OH)_2$ and $Zn(OH)_2$ are soluble in relatively small quantities of a solution of NH_3, but the solutions may be strongly concentrated over CaO or KOH without a precipitate being formed; finally, $Cu(OH)_2$ gives crystals of $CuO.4NH_3.H_2O$; the existence of this already-known compound gives rise to the supposition that copper forms hydrates more hydrated than $Cu(OH)_2$. These higher hydrates are known in the case of many metals, such as Ba, Sr, Ca, Zn, &c. The hydrates $R(OH)_2$ may unite, not only with H_2O, but also with other bases, such as the alkalis, which allows of the supposition that they are able to combine with themselves, forming polymers, $[R(OH)_2]n$. The insoluble hydrates appear to be polymers of this description; this hypothesis finds a basis in the constitution and properties of the basic salts, especially the salts basic to two bases like those which have been produced recently by Mailhe and by Recoura.—*Journ. Soc. Phys. Chim. R.*, vol. xxxiv., Part 2, p. 13.

MEETINGS FOR THE WEEK.

Monday, 11th.—Society of Arts, 8. (Cantor Lectures). "Mechanical Road Carriages," by W. Worby Beaumont, Mem.Inst.C.E.

Tuesday, 12th.—Royal Institution, 5. "The Astronomical Influence of the Tides," by Prof. G. H. Darwin, F.R.S.

Wednesday, 13th.—Society of Arts, 8. "Preservation of Big Game in Africa," by R. North Buxton.

Thursday, 14th.—Royal Institution, 5. "Proteid Digestion in Plants," by Prof. Sidney H. Vines, F.R.S., &c.

—— Society of Arts, 4.30. "The Province of Assam," by Sir James Charles Lyall.

Friday, 15th.—Royal Institution, 9. "The Origin of Seed-bearing Plants," by D. H. Scott, F.R.S., &c.

Saturday, 16th.—Royal Institution, 3. "Music" (with Musical Illustrations), by Hamish MacCunn.

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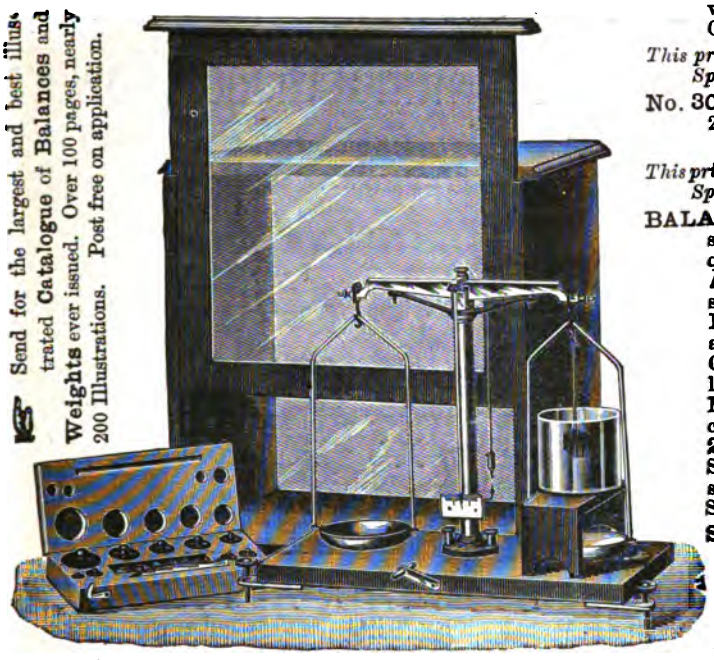

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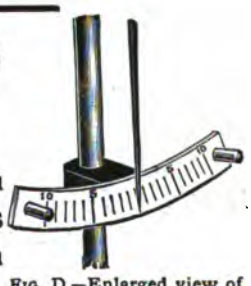

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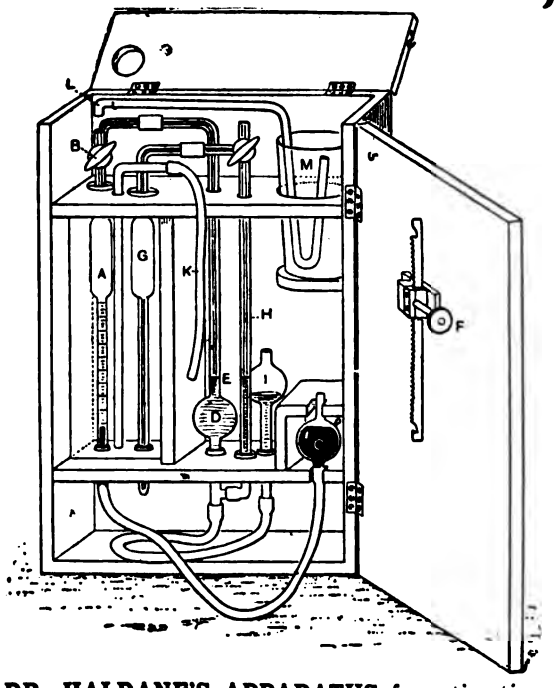

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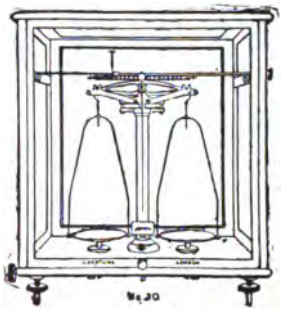

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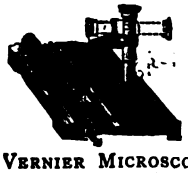

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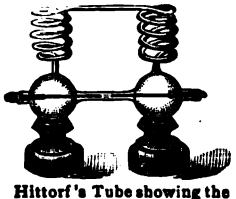

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VOL. LXXXVII., No. 2268.

SOME PHYSICAL PROPERTIES OF NICKEL CARBONYL.*

By JAMES DEWAR, M.A., Sc.D., LL.D., F.R.S., Jacksonian Professor in the University of Cambridge, and HUMPHREY OWEN JONES, M.A., Fellow of Clare College, Jacksonian Demonstrator in the University of Cambridge.

THE properties of nickel carbonyl have until recently been the subject of but few investigations. Dr. Mond and his collaborators in the discovery of this remarkable substance determined some of its physical properties, including its boiling-point, specific gravity, and vapour density. Subsequently, Dr. Mond, in association with Prof. Nasini, made observations on its molecular refraction and thermal expansion.

A substance of the peculiar molecular structure of nickel carbonyl seemed to call for further study. The investigation described in the present paper was carried out in the winter of 1901; the authors' intention being to make a complete study of the stability of the compound both in the gaseous and liquid conditions. While the work was in progress a paper by Mittasch was published (*Zeit. Phys. Chem.*, 1902, vol. xl., p. 1) containing an account of an admirable and exhaustive investigation of the velocity of the reaction between nickel and carbon monoxide, including the heat of formation and vapour tensions of the compound, covering part of the ground which we had examined. A number of interesting problems examined in the course of our inquiry however remain, which have not been touched upon by previous investigators, and to some of these the present paper is devoted.

The vapour density of nickel carbonyl was determined by Mond, Langer, and Quincke (*Journ. Chem. Soc.*, 1890, vol. lvii., p. 749) in air at 50° C. by Victor Meyer's method. The value obtained was 86·7, while theory requires 85. The vapour density at this temperature is quite normal, and there is no evidence of association even at this temperature, only some 7° C. higher than the boiling-point of the compound. It was found that the vapour exploded at 60° C. with a flash of light, and carbon dioxide was detected among the products of decomposition. Berthelot (*Comptes Rendus*, vol. cxii., p. 1343) explained the explosion as being due to the production of carbon dioxide by the intermolecular reaction $2CO = CO_2 + C$, which was observed to take place when carbon monoxide acts on nickel at 350—450° C. Later (*Ann. Chem. Phys.*, 1901, [7], vol. xxii., p. 304) it was found that the action only proceeded in this way to a small extent, when nickel carbonyl vapour was decomposed. The reaction $2CO = CO_2 + C$ liberates 38·8 kilogrms. calories, so that if the heat of formation of nickel carbonyl is less than 77·6 kilogrms. calories per molecule; this explanation would be valid. This condition is satisfied since Mittasch (*loc. cit.*) has shown that the heat of formation of nickel carbonyl is between 50·6 and 55·6 cals. Hence the detonation observed by Mond might result from the reaction—

$$Ni(CO)_4 = Ni + 2CO_2 + 2C.$$

The fact that nickel carbonyl was thus reported to be explosive, together with the explanation of its explosibility offered by Berthelot, strengthened the belief in its great instability and deterred experimenters from working with it, in any case at temperatures above its boiling-point.

The authors observed that when nickel carbonyl was suddenly heated in an atmosphere of some inert gas, such as hydrogen or nitrogen, the vapour decomposed quietly with deposition of metallic nickel; there was no explosion or flash of light, and the quantity of carbon dioxide produced was so small, in most cases, as to be almost negligible. This was found to be the case even when the temperature used was as high as 130° C. Mittasch (*loc. cit.*) states that he could detect no carbon dioxide when the compound decomposed below 100° C.

The explosion observed by Mond, Langer, and Quincke must therefore have been due to the presence of oxygen, and does not occur in its absence. The amount of carbon dioxide produced by the quiet decomposition is very small, so that the Berthelot reaction, though possible, only takes place to a very slight extent.

It was therefore clear that vapour-density determinations of the compound could be made in atmospheres of inert gases at temperatures much higher than 50° C. As vapour-density determinations of such a unique compound as nickel carbonyl under varying conditions would have a special interest and might well be expected to repay careful study, a large number of vapour-density determinations were made by Victor Meyer's method at temperatures between 63° C. and the boiling-point of naphthalene (216° C.), in order to ascertain the effect of increasing temperature on the dissociation of the compound. The vapour density apparatus was filled in different experiments with various dry inert gases, viz., hydrogen, nitrogen, and ethylene, all carefully purified and especially freed from oxygen.

In order to trace the effect of the rapidity of gaseous admixture on the dissociation, various forms of the vapour-density reservoir were employed. An atmosphere of carbon monoxide was employed to investigate the effect of the gaseous product of dissociation on the stability of the carbonyl.

It was found that the rate of admixture of the vapour with the gases had a marked effect on the dissociation, as shown by the difference in the vapour densities when taken under similiar conditions, in the various inert gases; and, further, that the presence of carbon monoxide produced the expected diminution in the amount of the compound decomposed. In order to further confirm this, two reservoir tubes of different bore were used, one having a cross-sectional area about three times that of the other (the latter will be referred to as the narrow tube) In the latter admixture could take place much less readily than in the former; consequently, the surrounding gas would be expected to have a smaller effect on the extent of the dissociation. This was also confirmed by the experimental results; the vapour density in the narrow tube is almost independent of the gas employed.

The effect of the nature of the surface on the extent of dissociation was tested by using the tubes coated internally with a film of metallic nickel deposited from the vapour of nickel carbonyl by heating. The film of nickel seemed to bring about a state of equilibrium more rapidly, so that the vapour densities determined in these tubes were lower than those in the same tubes not covered by nickel (a similar effect was observed by Mittasch).

It was found that the rate at which the liquid evaporated, as would be expected in the case of a substance which readily dissociates, had some effect on the extent of the dissociation. Hence, it was necessary, in order to get comparable results, to arrange that approximately the same time was taken for vaporisation in all the experiments made at the same temperature. A definite end-point could be observed in each case at which the gas displaced by the vapour ceased to come off, and a much slower evolution of gas took place. The experiment was stopped when the more rapid evolution of gas gave place to the slower.

The results obtained are given in Table I.

In the fourth column the percentages of nickel-carbonyl molecules dissociated are given, calculated from the formula $P = \frac{85 - D}{3D} \times 100$, where 85 is the theoretical vapour density of nickel carbonyl and D is the observed value.

* A Paper read before the Royal Society, March 26, 1903.

TABLE I.—*Vapour Densities Determined by Meyer's Method.*

Temperature of the bulb. °C.	Gas filling the bulb.	Vapour density found (H = 1).	Percentage of $Ni(CO)_4$ dissociated.	Remarks.
63	Nitrogen	83·3	0·7	Very slight deposit of nickel.
		78·2	2·7	Slight deposit of nickel.
64	Hydrogen	79·2		
66	Carbon monoxide	83·9	0·15	Nickel covered tube.
		85·2		
81 (benzene)	Nitrogen	71·0	6·2	Slight deposit of nickel.
		72·1		
100	Hydrogen	67·3	8·8	Nickel deposited over several inches in the tube.
		67·0		
		56·9	16·7	Wide tube covered with nickel.
		56·7		
		79 0	2·4	Narrow tube. Nickel deposit extended about 32 c.m.
		79 8		
100	Nitrogen	70·8	6·7	
		70·9	—	Wide tube.
		75·6	4·1	Narrow tube.
100	Ethylene	70 6	6·8	Wide tube. Nickel deposited over 2 c.m. from bottom of tube.
		70·7		
		73 7	4·3	Wide tube. Moist nickel carbonyl. Nickel deposited irregularly over about 3 c.m.
		76·7		
		77·8	2·7	Narrow tube. Nickel deposit extended 22 c.m.
		79 5		
100	Carbon monoxide	85·0	0·39	Wide tube. No visible deposit of nickel.
		83·1		
		82 6	0·6	Wide tube, covered with nickel carbonyl, dried over phosphorus pentoxide.
		84·5		
		76·4	3·87	Narrow tube. Slight deposit of nickel.
		76·0		
110 (toluene)	Nitrogen	48·4	25·4	Distinct deposit of nickel.
		48·1		
"	Carbon monoxide	75·2	4·4	Deposit of nickel scarcely visible.
		74·8		
129 (amyl alcohol)	Nitrogen	25·1	76·5	Extensive deposition of nickel over tube.
		26·4		
	Carbon monoxide	31·7	54·5	" "
		32·7		
135 (acetic anhydride)	Carbon monoxide	26·9	72·0	" "
155 (turpentine)	Nitrogen	22·5	94·3	" "
		22·5		
	Carbon monoxide	23·2	—	" "
		23·16	88·8	
182 (aniline)	Nitrogen	23·3	89 0	" "
		23·0		
	Carbon monoxide	24·4	82·8	" "
		23·3	88·2	
216 (naphthalene)	Nitrogen	22·4	93·0	" "
		22·44		
	Carbon monoxide	(20·9)		
		21·3	99·7	

TABLE II.—*Vapour Densities of Nickel Carbonyl by Hofmann's Method.*

Temperature of bath. °C.	Vapour density.	Pressure in m.m. of mercury.	Percentage of nickel carbonyl dissociated.	Percentage dissociated at atmospheric pressure.	
				In nitrogen.	In carbon monoxide.
17	85·6	67·7	0·0		
35 (ether)	81·8	161 4	0 13		
78 (alcohol)	62·6	217·8	11·9	4·1 at 100° C. in narrow tube.	3·87 at 100° in narrow tube.
129 (amyl alcohol)	25·2	389·4	79·1		
	23 8	365·6	85·7	76·5 (wide tube).	54·5 (wide tube).
182 (aniline)	21·5	349·0	98·4		
	20 8	320 6	—	Practically complete in wide tube.	
	21·7	356 0	95·7		

Unless otherwise stated, it is to be understood that the determination was made in a Victor Meyer's apparatus of the usual type, occasionally referred to as the wide tube.

From the figures in the above table, it is seen that the value of the vapour density, deduced from the experiments in the wide tube, is greater in ethylene than in nitrogen and hydrogen. It was also noticed that the deposit of nickel in the latter two gases extended higher up the tube than in the former, and was higher in hydrogen than in nitrogen. In carbon monoxide, on the other hand, the vapour density is higher than in the gases, hydrogen, nitrogen, or ethylene, the values at 100° C. being nearly normal, and the dissociation was incomplete even in aniline vapour. This demonstrates very clearly the effect of the presence of one of the dissociation products on the amount of the dissociation.

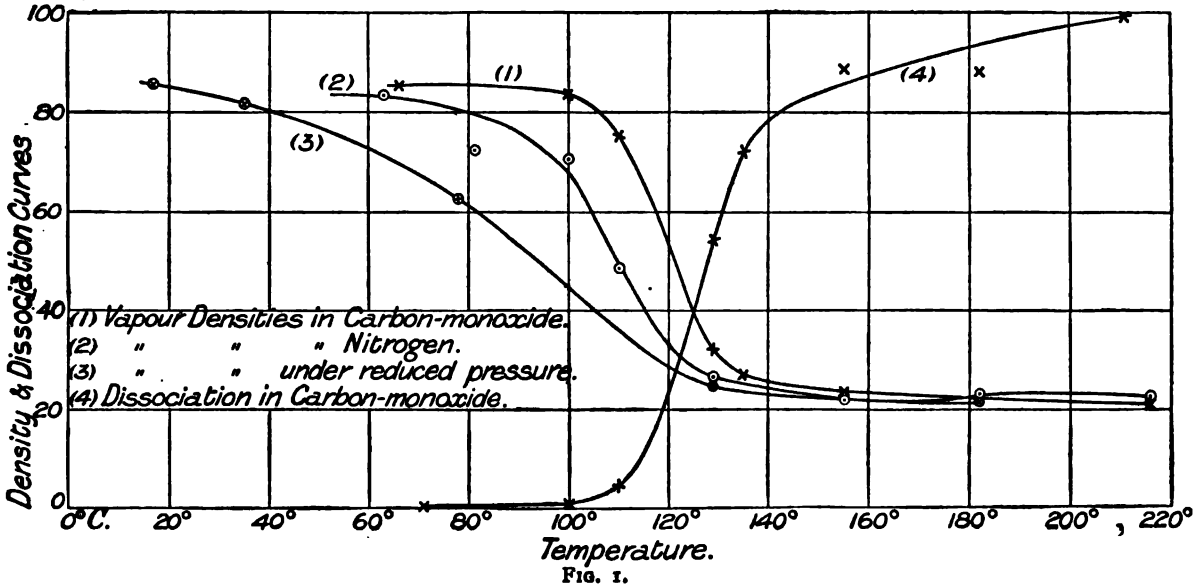

Density & Dissociation Curves
Temperature.
(1) Vapour Densities in Carbon-monoxide.
(2) " " " Nitrogen.
(3) " " under reduced pressure.
(4) Dissociation in Carbon-monoxide.
0°C. 20° 40° 60° 80° 100° 120° 140° 160° 180° 200° 220°
0 20 40 60 80 100

FIG. 1.

In the narrow tube, however, the values obtained at 100° C. do not seem to depend, to any great extent, on the nature of the surrounding gas, the values in carbon monoxide and in the inert gases being almost identical, which shows the great effect of rate of admixture and diffusion on the dissociation.

The amount of dissociation increases rapidly with the temperature; in nitrogen at 155° C. it is practically complete. The rate of increase in carbon monoxide is distinctly slower, the difference between the vapour densities in nitrogen and carbon monoxide at 129° C. being quite marked. Above 155° C. the results obtained are somewhat irregular; but dissociation seems to be nearly complete at atmospheric pressure, since only a small deposit of nickel could be obtained when the tube was placed horizontally and a clear part heated with the blowpipe.

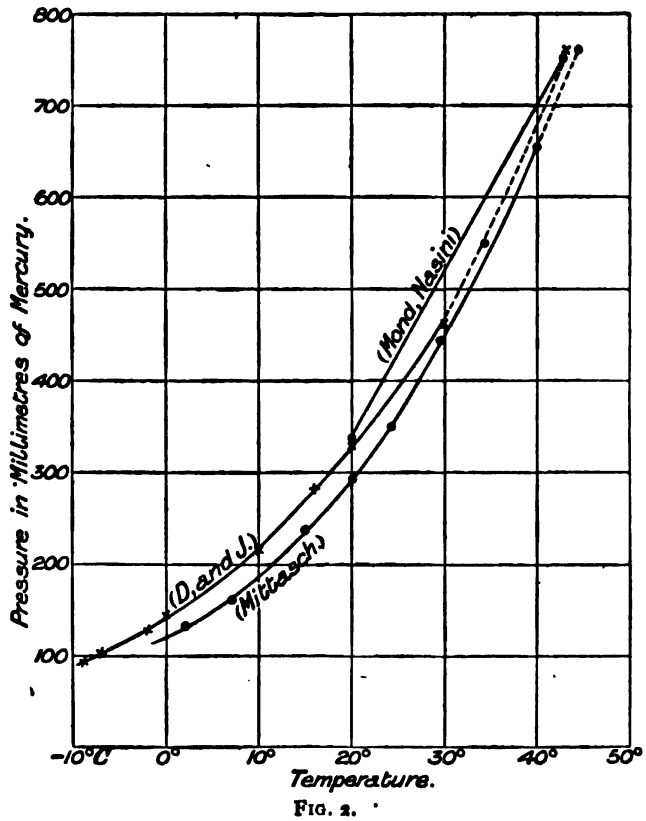


FIG. 2.

A few vapour-density determinations were also made by Hofmann's method at temperatures been 17° C., and the boiling-point of aniline (182° C.), in order to observe the dissociation of the undiluted vapour. Complete dissociation is practically reached at 182° C., but even then the application of a pointed flame to a clear portion of the tube produced a slight deposit of nickel, so that traces of nickel carbonyl were still present.

The results are given in Table II.

The results of the experiments in the narrow tube are given in the fifth column for the sake of comparison, the phenomena in this case being practically the dissociation of the vapour in contact with its own dissociation products. The dissociation is clearly greater under reduced pressure, as might be anticipitated.

The general results of the vapour-density determinations are readily seen from the curves in Fig. 1.

Having thus found that the vapour of nickel carbonyl was much more stable at elevated temperatures than had hitherto been suspected, we resolved to examine the stability of the liquid under pressure, and if possible make observations on it as far as its critical point.

Small sealed tubes from one-half to one-third full of nickel carbonyl were heated to 200° C. without bursting. A small quantity of nickel was deposited on the first heating, and it was found that its quantity was not appreciably increased on repeating the operation. On standing a sufficient length of time at the ordinary temperature the nickel gradually dissolved again, although it was covered by the excess of liquid. This proved in an interesting

manner the ease with which the reaction between the deposited nickel and carbon monoxide is reversible.

The amount of the nickel deposition was notably greater when the liquid was heated in contact with mercury, so that the use of the Cailletet pump for the examination of the critical phenomena was not practicable.

Rough measurements of the critical temperature were made by observing the temperature at which the meniscus disappeared and reappeared, when a quantity of the liquid was alternately heated and cooled in an exhausted and sealed-off piece of glass tube of 2—3 m.m. bore. The tube was heated side by side with a thermometer in a glycerine bath, and was so arranged that it could be inverted at will. The temperatures at which the meniscus disappeared and reappeared, in the course of many repeated observations with different samples of material, ranged between 191° C., and 195° C.

It appears from the observations made with such tubes that the most reliable results were obtained the first time they were heated, the meniscus being better defined and disappearing more sharply than on subsequent occasions. The blurred effect noticed on a repetition of the experiment is due to a somewhat greater amount of carbon monoxide being present.

The presence of carbon monoxide would be expected to cause a lowering of the temperature at which the meniscus disappeared, and this expectation was realised in the course of the experiments. Hence the temperature observed in the first experiment is probably below the true critical temperature. The presence of 4—5 per cent of carbon monoxide with its low critical temperature 128° abs. would be expected to lower the temperature at which the meniscus disappears by about 5° C. That this quantity of carbon monoxide might be present at any time is shown by the following experiment:—

Volume of tube, 1·35 c.c.
" nickel carbonyl left after heating to 193° C. = 0·437 c.c.
Amount of nickel deposited = 0·0147 grm.
" carbon monoxide liberated = 0·0284 grm. = 5·02 per cent of the residual nickel carbonyl.

Hence it is very probable that the true critical temperature is about 200° C.

Comparative experiments made with pure ethyl ether in similar tubes gave a critical temperature of 193° C. The accepted value for the critical temperature for ether being 194·5° C., the observed temperature for nickel carbonyl cannot be far removed from the correct value.

The formula $T_b = 0{\cdot}66\ T_c$, where T_b is the absolute boiling-point and T_c the absolute critical temperature, should be applicable to the case of nickel carbonyl, since it is applicable to ether, a liquid which has a critical temperature of approximately the same value. Taking the boiling-point to be 43·3° C., the critical temperature calculated from the above relation would be 201·4° C., which agrees very well with the value which was found as a probable minimum critical temperature.

Although it had not been surmised that nickel carbonyl could ever stand heating above 100° C., nevertheless Mond and Nasini (*Zeit. Phys. Chem.*, 1891, vol. viii., p. 150) calculated the hypothetical critical temperature of nickel carbonyl from the results of their experiments on its coefficient of expansion by means of a formula given by Thorpe and Rücker, and found the value 151° C. In a similar manner Ramsey and Shields (*Journ. Chem. Soc.*, 1894, vol. lxiii., p. 1108) calculated the critical temperature from the temperature coefficient of the molecular surface energy. The value deduced in this way is 182·8° C. It therefore appears that the hypothetical critical temperature calculated by either of these methods falls considerably below its actual value.

Rough indications of the critical pressure were obtained by introducing into the sealed tube containing the nickel carbonyl a small tube of very fine bore, closed at one end and having a small globule of mercury introduced at the other, to act as a manometer. The position of the globule was observed at the ordinary temperature, and again at the critical point. The volume of the air in the small tube occupied about one-thirtieth of its original volume at the latter temperature, so that the pressure in the tube seems to be rather more than 40 atmospheres at the critical point. On cooling, the indicating globule remained permanently displaced some distance up the tube, showing the existence of a pressure developed by the decomposition of the nickel carbonyl. On standing for some time the whole of the nickel disappears, and the carbonic oxide pressure disappears.

The pressure on cooling seemed to be about ten atmospheres, hence the critical pressure would be about thirty atmospheres. Later it will be shown that this is near the actual value.

The critical constants of the compound being known, together with the boiling-point, it is possible to calculate a vapour-pressure curve. It was, however, thought better to determine the vapour-pressure at a number of temperatures below the boiling-point of the liquid, by the static method, and from this curve by extrapolations to deduce the values for higher temperatures.

A wide barometer tube (about 0·7 c.m. diameter) was carefully cleaned, dried and drawn off, to a fine capillary tube at one end. The tube was then placed upright in a vessel of pure dry mercury and exhausted thoroughly with a Fleuss pump. A small tube full of nickel carbonyl was now introduced at the bottom of the tube, and the whole then exhausted again, while surrounded by a freezing mixture, in order to get rid of all adhering air, and finally sealed off rapidly at the fine capillary. By this method of procedure only a very small amount of decomposition took place during the sealing off, as indicated by the very slight deposit of nickel. The pressure was then read off by means of a kathetometer, while the tube was surrounded by a bath kept at various constant temperatures.

The results are appended below, together with those obtained by Mittasch (*loc. cit.*) by the dynamic method.

Dewar and Jones.		*Mittasch.*	
−9° C.	94·3 m.m.	2 05° C.	133·1 m.m.
−7	104·3	7·5	170·5
−2	129·1	15·27	238 2
0	144·5	20·2	294·3
+10	215·0	24·26	349·7
+16	283·5	29·52	444·2
+20	329·5	34·29	532·6
+30	461·9	39·97	647·2

The values for − 9° C. and + 30° C. give the following Rankine formula for the relation between the pressure p in millimetres of mercury and the absolute temperature T. $\log p = 7\,355 - 1415/T$. At 200° C. (about the critical temperature) the pressure calculated from this equation is 30·4 atmospheres. Taking the results obtained by Mond and Nasini, viz., the boiling-point 43° C. 751 m.m., and the pressure at 20° C., 338 7 m.m., a similar expression, $\log p = 7{\cdot}281 - 1392/T$, is obtained.

Taking Mittasch's pressures for 2° C. and 40° C. the Rankine obtained is:—

$$\log p = 7{\cdot}781 - 1555{\cdot}7/T.$$

The boiling-points calculated from these formulæ are given below:—

Mond	43·3° C.
Mittasch	44·4°
Dewar and Jones	43·2°

In order to further confirm our vapour-pressure determinations, we made a determination of the boiling-point of some carefully dried and re-distilled nickel carbonyl. With the barometer at 769 m.m. the liquid boiled at 43·2—43·33° C.

It would therefore appear that our vapour tension curve is the more accurate. The curves, fig. 2, illustrate very

clearly the extent of the deviations at different temperatures.

The latent heat of vaporisation of $Ni(CO)_4$, is 38·1 calories per grm. and the Trouton constant (molecular latent heat divided by the absolute boiling-point) is 20·6, its value for ether being 22. The number obtained by dividing the absolute critical temperature by the critical pressure, which is proportional to the volume of the molecule, Van der Waal's constant b, is 15·5; the similar number for carbon monoxide is 3·7, so that nickel carbonyl according to theory has a molecule 4·2 times larger than carbon monoxide. The molecular volume of nickel carbonyl at its boiling-point is 136 as compared with 110 for ether. The critical density appears to be about 0·46, while that of ether is only 0·25. If the liquid densities of Mond and Nasini (*loc. cit.*) are taken with the critical data, then the Waterston formula $v = 2·0398 - 0·5667 \log (198·7 - t)$ fits in very well with the results. A similar formula for ether given by Avenarius is :—

$$v = 3·19 - 0·802 \log (191 - t)$$

The molecular volume of nickel carbonyl at its boiling-point is 136; subtracting from this 7·2 for the nickel atom, we have 32·2 as the volume of each molecule of carbon monoxide in the molecule. Now liquid carbon monoxide at its boiling-point has the molecular volume of 35, so that contraction would take place if liquid carbon monoxide could combine with nickel. The heat of formation of nickel carbonyl is about four times greater than that of the liquefaction of the equivalent amount of carbonic oxide under normal conditions.

The experiments described above show clearly that nickel carbonyl is a substance admirably suited for the demonstration of the phenomena of dissociation. Great care must, however, be taken in handling the substance owing to its poisonous properties when inhaled. It also forms an excellent illustration of a reversible reaction, and the following experiments serve to illustrate the way in which it may be used for this purpose.

A number of carefully dried tubes were exhausted by means of a Fluess pump, and were then filled with a mixture of 10 per cent nickel carbonyl vapour and 90 per cent carbon monoxide, at pressures of 50, 100, 226, 304, 396, 504, and 624 m.m. of mercury respectively. These tubes were then heated in a bath until nickel began to deposit; the tube under observation was then kept at that or a slightly higher temperature for about half-an-hour, and afterwards tested for the presence of nickel carbonyl by heating a clean portion of the tube with a fine pointed flame, and in this way the presence of even a very small trace of nickel carbonyl was immediately detected by the formation of a bright mirror of nickel on the hot part of the tube. The tube at 50 m.m. pressure did not deposit nickel when placed in alcohol vapour; but did so at 100° C., and, after heating for a few hours at this temperature, no nickel carbonyl could be detected in the tube. After standing for a few days, however, nickel was deposited when a clean portion of the tube was heated with a pointed flame, thus showing that nickel carbonyl had been regenerated. In the 100 m.m. tube nickel was still deposited after heating for two days at 100° C.; all the nickel carbonyl was found to have disappeared after the tube had been heated for some time to 130° C. Nickel was deposited in the tube at 226 m.m. pressure at 130° C., in the 301 m.m. tube at 158° C., and in the other tubes at slightly higher temperatures. In the two tubes at the highest pressures there was a considerable quantity of the carbonyl present after heating for an hour at 160° C. All the tubes in which the nickel carbonyl had been so far destroyed that no visible deposit of nickel could be obtained on heating a clean portion of the tube with a small flame, after standing for a few days contained enough of the carbonyl to be readily detected by the above test.

Another form of experiment suitable for demonstration proved the reaction proceeded rapidly at the ordinary temperature, and with a measurable velocity at low temperatures, even when the pressure of the carbonic oxide atmosphere was below 200 m.m. A large bulb of about 200 c.c. capacity was connected to a mercury manometer of small bore (so that the movements of the mercury in the manometer were proportional to the changes of gas concentration in the bulb). The bulb was highly exhausted and then filled with pure nickel carbonyl vapour to a pressure of 51 m.m. of mercury at 15° C. After heating for about an hour to 100° C., the pressure, measured after cooling, had risen to 143 m.m, corresponding to a decomposition of about 60 per cent of the nickel carbonyl present. Heated in a glycerine bath to 154° C., the pressure reached 198 m.m. corresponding to practically complete decomposition, which ought to develope a total pressure of 204 m.m.

On rapidly cooling the bulb and allowing it to stand at the ordinary temperature, the pressure fell, at first, about 3·2 m.m. in an hour, then after two days it had fallen to 120 m.m., or about 55 per cent had re-combined; after four more days the pressure was 97 m.m., or about 60 per cent had re-combined; after standing four weeks some of the deposited nickel remained unattacked.

The bulb was again heated to 150° C. so as to deposit all the nickel on the lower part of the tube, and the pressure now rose again to 200 m.m. The lower part of the bulb where the nickel had deposited, was now immersed in liquid air, when it was observed that still a small but distinct diminution in pressure took place after some hours. Liquid carbonic oxide did not, however, appear to react with nickel reduced from the oxide by hydrogen.

The volatile iron carbonyl has been made the subject of a number of similar observations, dealing with its physical properties and chemical stability, which will be discussed in another communication.

ANALYSIS OF VOLCANIC DUST FROM LA SOUFRIÈRE.

By JOHN BRIDGEFORD COPPOCK, F.I.C., F.C.S.

This dust fell in Barbados on May 7th and 8th, 1902, and was a product of the activity of La Soufrière.

An analysis of the dust yielded the following figures :—

	Per cent.
SiO_2	53·95
TiO_2	0·82
P_2O_5	0·12
SO_3	0·37
Cl	0·22
Al_2O_3	19·21
Fe_2O_3	2·95
FeO	4·78
CaO	8·85
MgO	4·15
Na_2O	3·82
K_2O	0·71
MnO	0·31
	100·26

This analysis was made on material dried at about 120° C.

Traces of copper and nickel are present, but cobalt could not be detected. The presence of a small amount of olivine would account for the presence of copper and nickel. Olivine is characteristic of the St. Vincent volcanoes, which are two near neighbours of La Soufrière; apparently microscopic analysis fails to detect any particles of olivine.

The following physical facts were also determined :—

Average weight of largest particles	0·0001 grm.
Average volume	0·000036 c.c.
Specific gravity	2·6
Magnetic material	3·3 per cent.

Magnetite is a very characteristic constituent of the ash, even perfect octahedra being found.

Science Schools, Stroud, Glos.

THE STRUCTURE OF SPECTRA.*

By Prof. CH. FABRY.

(Concluded from p. 220).

IV. *Satellite Lines.*

THE doublets or triplets of certain metals offer curious peculiarities which merit more than a passing notice.

Take, for example, the mercury spectrum, where we find triplets forming two series, the diffuse series of Rydberg and the fine series. Each triplet of the diffuse series is formed, not of three simple lines, but of several; the first element of the triplet is formed of four lines very close together, the second of three lines, and the third of two. We may look upon each element as being formed of a principal line accompanied by satellites. The same aspect holds good for the other triplets of the series.

On the other hand, the lines of the narrow series appear to be simple lines.

It is quite possible that this simplicity is only apparent, and is due to the fact that the satellites are too close together to be separated with the ordinary spectroscopic apparatus in use. The following facts appear to me to support this opinion. Some years ago, Michelson described a method for obtaining metallic lines of great sharpness by an induction discharge in vapour at low pressure, and at the same time a very accurate interference method to see whether a line is simple, or accompanied by satellites very close to it.†

The position of these satellites remained undetermined up to a certain point; a little later, M. Perot and I published a method by which means these satellites can be seen separately, and which constitutes a complete spectroscopic method more powerful than had been available up to that time. The application of these methods first gave an unexpected result; most of the lines examined by Michelson were shown to be complex; their components, it is true, being too close to each other for the old spectroscopic apparatus to separate them. Of ten metallic lines examined, only two were found to be simple ones. In face of such a proportion it became natural to ask if the fact was a general one, and if the majority of spectral lines dissected, so to speak, by the new methods would all be resolved into clusters of lines. Further observations have not confirmed this fear. Of ten cadmium lines examined by M. Hamy by means of his tubes without electrodes, only the three lines already examined by Michelson were found to be complex. Of eleven lines belonging to different metals examined by M. Perot and myself by means of our spark trembler *in vacuo*, only one copper line was found not to be simple.

Now it happens that it is exactly Michelson's complex lines that belong to Rydberg's narrow series, and it is these that he has examined, as it is in this series that the most brilliant lines of the visible spectrum are found.

Thus, we may take it, at least as a reasonable hypothesis, that all the lines of the secondary series are accompanied by satellites; those of the diffuse series by satellites sufficiently wide apart to be distingu shed with the ordinary spectroscopic apparatus; those of the narrow series by satellites very closely placed. All the satellites appear to have the common property of showing a very varied brilliancy according to the conditions of production, such as temperature, pressure, nature of the electric current, &c. There is one fact that M. Perot and I have observed numbers of times in the case of the satellites of Michelson lines, and which is probably true also for the longer known satellites of the diffuse series; one silver line of wave-length 547·2 disappears completely when we use a spark *in vacuo*, while it is of considerable intensity when the spark is produced in air; now this line is a satellite of the line 546·6.

The classification of the lines is not always as complete as in the case of the alkaline metals; with these latter all the lines belong to the three series of pairs; with the other metals there remains a more or less considerable number of lines which are beyond classification. As a general rule the lines which make up the regular series are those which appear at a relatively low temperature (Lockyer's *long rays*); among these are found the spontaneously reversible lines of Cornu. In the spark spectra, which correspond probably to a much higher temperature of emission, the number of lines is considerably greater, and the number of lines classified forms only a small fraction of the total number.

In fact, a certain number of metals give extremely complex spectra of which the lines have escaped classification up to the present; such are the metals of the iron family (Fe, Ni, Co, Mn). Must we admit that their structure is different from that of the metals already examined, or only that the confusion between the series is such that it has not yet been disentangled? The problem would be simplified greatly if we had any criterion by which we could recognise analogous lines.

Their appearance only gives very insufficient data, and we must come to the examination of the properties of the different lines. Up to the present time we know of two phenomena which produce an alteration of the wave-lengths:—Increasing the pressure of the surrounding gas (Humphreys and Mohler) and the production of a magnetic field (Zeeman). The study of these two phenomena is hardly commenced; it has, however, already given very interesting results so far as the classification of the lines is concerned.

V. *Zeeman's Phenomenon.*

The presence of a magnetic field profoundly modifies the emission of light by gases; each line is transformed into a group of lines, differently polarised, and of which the separation goes on increasing with the intensity of the magnetic field. Such is the fact discovered by Zeeman, and which is of such prime importance.

The details of the phenomenon appeared to the first observers who undertook its examination, of an almost discouraging complexity; every line seemed to behave in a different manner without any connection with the conduct of the others. However, the works of Cornu, Michelson, Preston, and especially that of Runge and Paschen, have succeeded in bringing some order out of this chaos, and have reduced them to simple laws, at least for the lines forming part of the regular series.

The different lines forming a definite series behave in an identical manner, so that if we represent each line by its frequency these various lines are transformed in the magnetic field into superposable groups.

Further, there exist simple relations between the manners in which the different series behave. Let us consider an example, taking the spectrum of mercury. The narrow lines of Rydberg form a series of triplets, or, if we prefer it, three parallel series of simple lines which we may call *a*, *b*, and *c*; in each triplet the line *a* is the one with the greatest wave-length. Let us take an *a* line. In the magnetic field perpendicular to the direction of emission, it decomposes into 9 equidistant components symmetrically placed with regard to the original simple line (Fig. 6). These can be designated by the figures 0 (the central line) +1, +2, +3, +4 (on the right), and −1, −2, −3, −4 (on the left). The lines +1 and −1, +2 and −2, &c., are of the same intensity, and are polarised in the same manner. The lines 2, 3, 4, are polarised in the plane of the lines of force; the lines 0, 1, 2, in the perpendicular plane.

* *Revue Générale des Sciences*, Year XIV., No. 5, March 15, 1903.

† A. Michelson "Les Méthodes Interferentielles en Métrologie," *Revue Generale des Sciences*, June 30th, 1893, vol. iv., p. 369.

One single numerical constant governs the disposition of this complicated group, viz., the distance between two consecutive lines.

The lines *b* and *c* give groups with different aspects, but which may be looked upon as simplifications of the group of nine lines. Without changing the intervals, nor the directions of polarisation, it suffices to modify the intensities of the lines to efface some of them. Fig. 6 gives the form of these groups. To sum up, we may say that all the narrow lines of mercury give, in an equal magnetic field, the same grouping of nine equidistant lines, but differing only in the relative intensities of the different lines; some can be reduced to zero.

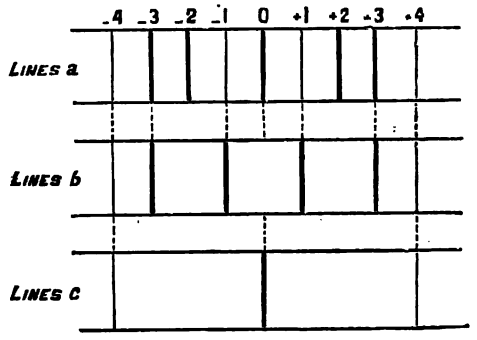


Fig. 6.—Action of a Magnetic Field on the Mercury Lines belonging to the Narrow Series.

Without being able to show in this article, owing to lack of space, the analogous results obtained in other cases, this example should be sufficient to demonstrate the simplicity introduced into the study of this delicate phenomenon, the classification into series. There are many natural families of which the members behave in an identical manner under similar circumstances. We may hope that inversely the study of Zeeman's phenomenon in the cases of spectra not yet disentangled will help us considerably in the recognition of members of the same family. But this is a work that will require a good deal of time, since it is necessary to make an individual and delicate examination of lines which are to be counted by thousands. From this point of view, some interesting results obtained by Messrs. Becquerel and Deslandres on the spectrum of iron, enable us to state that this work will not be unproductive.

The study of Humphreys and Mohler's phenomenon (displacement of lines under the influence of pressure) is still less advanced. We can already foresee, however, that the analogous lines behave in the same manner.

VI. *Absorption Spectra and Band Spectra.*

Kirchoff's law established a connection between emission and absorption spectra; we can make an absorption spectrum correspond in many cases to an emission spectrum, as it is its inverse; or in other words, it is composed of detached lines of darkness on the brilliant background of a continuous spectrum, and occupying the place of the brilliant lines of the emission spectrum.

The material facts which led Kirchhoff to the discovery of the law which bears his name certainly have not changed for thirty years; the two D lines still exist in the solar spectrum, occupying exactly the same place as our two sodium lines; in it we can always find thousands of lines each of which exactly occupies the place of a brilliant line of the iron spectrum, and these facts have lost none of their interest. However, the numerical relationship announced by Kirchhoff does not appear to be so general as it did. Kirchhoff treated as special cases, explicitly excluded from his reasonings, all cases in which bodies are luminous independently of their temperature, in which the radiating energy is obtained from another source than the calorific energy of the body in question. This is the case of a piece of phosphorus exposed to the air, and luminous though cold; it is also the case of phosphorescent and fluorescent bodies.

To-day we give the name of luminescence to all emissions of this nature, reserving that of incandescence for the cases of emission by heat alone (for example, the emission produced by a piece of red-hot iron).

Kirchhoff's reasonings apply to incandescent bodies, and not at all to luminescent ones. Now this, which appeared to be an exception, indeed almost a curiosity, is perhaps, on the contrary, a very frequent case. According to the recent researches of the physicists of the German school, the emission from gases would appear to be due more often to a phenomenon of luminescence than of incandescence. The illumination of a gas by means of electric discharges should in no way be allied with the elevation of temperature (sometimes very problematical) of the gas. A flame of dirty alcohol would be luminescent; that is to say, that pure sodium vapour of the same density and temperature as that existing in the flame should be much less luminous than the former. If this is the case, Kirchhoff's law applied to gases is reduced to this:—If a gas can emit a certain radiation by luminescence, it often happens that it is capable of absorbing it. Perhaps that is not always true, for we know of many beautiful lines which have never been seen reversed.

Inversely, we know of many absorption spectra to which no corresponding emission spectra are known. Such is the remarkable absorption spectrum of oxygen which gives place to the telluric groups A, B, and α of the solar spectrum. Should oxygen heated to above red-heat give the corresponding emission spectrum? It has never been observed, and it is very doubtful.

We may even ask ourselves whether, at a high temperature, the absorption spectrum of oxygen should not disappear. In fact, the little that we know about the absorbent properties of gases seems to indicate that these properties are modified at a high temperature. The vapour of iodine becomes colourless at a red-heat, and there is nothing absurd in the idea that oxygen might cease to absorb the radiations A, B, and α at a sufficiently high temperature.

That would explain the two following facts, which otherwise are contradictory:—The lines A, B, and α seem to be purely telluric, still the existence of oxygen in the sun appears to be thoroughly demonstrated by the presence of black lines which are not telluric in the solar spectrum, corresponding to the lines of one of the emission spectra of this gas, and which should form part of its absorption spectrum at a high temperature.

These absorption spectra, of which we do not know the inverse spectra, are generally band spectra formed of a very large number of lines grouped together in a confined space. Each of these spaces shaded with lines is called a band, but it happens sometimes that the bands, more numerous or closer together, encroach one on the other which gives rise to considerable complications. Often the arrangement of the lines in a band shows remarkable regularity. Fig. 7 shows the absorption band of oxygen, which in the solar spectrum forms the group A.

We observe that the arrangement of the lines justifies the following remark by Langley:—"When, after having looked through the solar spectrum, we meet with one of these groups (A or B), we become conscious of the same feelings that would be experienced by a traveller who, after wandering for a long time in a virgin forest, arrives suddenly at a well laid out park."

Several emission spectra also have this appearance of the bands. Among the most beautiful we may mention the spectra of carbon and of cyanogen, such as are given by the electric arc. The lines are to be counted by the thousand, and they are arranged with remarkable regularity, which does not include extreme complication.

In spite of this regularity, more easy to appreciate than in the line spectra, the band spectra are less well-known.

It is true that the number of lines being much greater, the data take longer to arrange, and the numerical laws have to satisfy much more stringent conditions.

The structure of a band is generally as follows:—It commences brusquely at a point of the spectrum which is called the head or edge of the band. Starting from the edge we first meet with the most brilliant and the narrowest lines; as we get further from the edge the lines become fainter and wider apart. Sometimes, starting from the edge, the lines go towards the red, but more often they extend towards the violet.

With a very slight dispersion, such a group would appear as a band, sharp on one side (the edge) and diffused in the other.

This appearance of the bands reminds us of the arrangement of the series in the line spectra, but with great differences. In the line spectra, the lines also become closer together as we approach the limit of the series; but they appear to be infinite in number with decreasing brilliancy, while in a band, when nearing the head or edge, we find a definite number of lines and increasing brilliancy.

Often from the same edge, not only one, but two or three series of lines start, all situated on the same side of the edge and distributed in an analogous though not identical manner. The result of this is very complicated arrangements of doublets and triplets; if, for example, we have two series starting from the same edge but with slightly different intervals, we should have alternately double and simple lines on account of the mingling of the two series. If there are three series, the complication might become inextricable, the more so as there is no characteristic to distinguish the lines of these three series, each one of which may consist of hundreds of lines. We have seen already in line spectra more than one series converging towards the same limit, but with much less complication, although the number of lines may be infinite.

We need not be surprised, in the face of such complications, that the study of these bands has attracted but few observers.

In a beautiful research on the band spectrum of nitrogen, M. Deslandres has come to the conclusion that in each series the frequencies are to be expressed by a formula of the form $N = a + bm_2$, a and b being two constants, and N the frequency of the line m. In other words, the intervals between successive lines increase in arithmetical progression. From the same edge or head as many as four analogous series may start, but each will have a different coefficient.

Starting from the edge of a band, if we advance on the side where the lines are, we generally find a second edge at a greater or less distance from the former. Sometimes this second edge is so far from the first that the lines of this latter may be already faint, then we can say that there is no confusion; but often this is not the case, and the series starting from the two edges become more or less entangled. Beyond this second edge we may find a third, and so on. All the bands issuing from these various edges form a group of bands, of which the appearance may be most confusing. Again, several observers have determined the exact position of edges which can be recognised easily by means of their greater density, and the increased brilliancy of the lines issuing from them. It is found that the repartition of these edges is analogous to that of the lines of a band. The first edge is the most brilliant, and starting from this one the successive edges become further and further apart.

From the above it is evident that all the lines of a group of bands form a coordinated whole, which we may attempt to represent by a single formula. The simple formulæ, such as those given by M. Deslandres, only give approximate results when the number of lines represented is very great. An attempt at exact representation, made by M. Thiele for one of the carbon bands, led to excessively complicated formulæ, which can only have the value of empirical formulæ.

VII. *Conclusion.*

Whatever results may have been attained up to now, the problem of the repartition of the lines of the spectra is, as we can see, far from being entirely solved. There still remains to be asked, what is the explanation of the experimental laws found, and what are the consequences from the point of view of the emmission theory of light? This theoretical side of the question is as yet hardly touched upon, and we may ask ourselves whether all speculation of this nature would not be premature. Doubtless it would not be impossible to imagine vibrating systems capable of producing the vibrations met with in such or such a spectrum, but would this exercise of the imagination have any notable influence on the progress of spectroscopy.

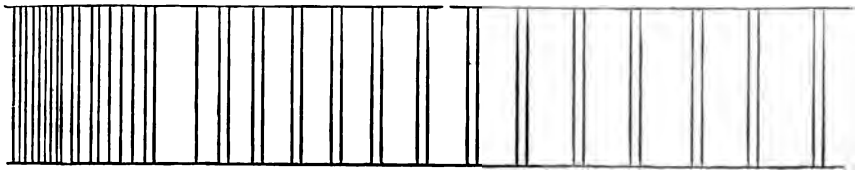


FIG. 7.—ABSORPTION SPECTRUM OF OXYGEN (Band A).

Let us mention some ingenious researches made in this direction by Mr. Johnstone Stoney, who has pointed out some curious relations between planetary movements and those which must be imagined for the purpose of explaining the spectra; in spite of the ingenuity of these relationships we do not see very clearly the cause of these astro-molecular movements.

More recently Mr. W. Sutherland has attempted to connect the laws of regular spectra with the theory of ions, to which Zeeman's discovery brought such striking confirmation. I will only mention these attempts, as I wish here to confine myself entirely to facts.

In the case of absorption spectra, the problem can be presented from another point of view. Although many of these spectra occur in the form of very fine black lines, the absorption is none the less a continuous function of the wave-length, rapidly variable it is true in the neighbourhood of some values.

We could only be really certain of the absorbent properties of a gas if we knew thoroughly the law of the variation of the absorbing power in functions of the wave-length, whereas the position of the black lines only indicates the positions of the maxima of this function. Thus put, the problem becomes closely allied with another, viz., that of abnormal dispersion. The optical properties, relative to a monochromatic radiation, of an isotropic medium are characterised by two constants; its index of refraction, which defines the speed of propagation of the luminous wave, and its index of extinction or its absorbing power which defines the gradual disappearance of this wave as it proceeds. These two quantities are functions of the wave-length.

Numerous researches have shown that neither is independent of the other; the fluctuations of the absorbing power are shown by inflections of the curve of the index. The examination of one of these variable functions cannot

be rationally dissociated from the other. Even the case of ordinary dispersion, that of colourless vitreous substances, can be connected with the latter, as transparent bodies probably only differ from absorbent ones by the particular position of their absorption bands, situated beyond those portions of the spectrum that we can examine most easily. We may hope that the closer study of spectra will one day help to elaborate the theory of dispersion put forward by by Cauchy more than sixty years ago, and not very much advanced to day.

EXPERIMENTS IN FILTRATION.

By GEORGE FREDERICK HORSLEY.

If two precisely similar precipitates be washed on two precisely similar papers and funnels, for exactly one minute in each case, the one by means of fifty minute additions of water, the other by means of five much larger additions; then, in spite of these different conditions, and in spite of the fact that the total washing liquid used will be quite different in the two cases, still the precipitates will be left contaminated with precisely the same amount of impurity.

The proof consists in an elementary application of the calculus, taking as datum the well-known law of the velocity of fluids in thin tubes. But it depends upon the assumption that the surface of the filter paper is nowhere hindered from fulfilling its function by the enclosing vessel or the contained precipitate, and experiments were accordingly made to test its application under these unfavourable—but practical—conditions.

By making a record of the time when each successive drop of a mixture of ink and water left the funnel, it was easy to obtain remarkably even curves showing the amount of liquid which had passed through the paper at any interval of time after commencing an experiment. It was found that with a strongly ribbed funnel the filtration of ink and water obeys the theoretical law. As the time increases in arithmetical progression, the quantity of liquid contained in the funnel diminishes in geometrical progression. When a plain funnel was used, a deviation occurred, owing to the sides of the paper being impeded as compared with the small open cone at the base. But when a precipitate of ferric hydrate containing 0·1 grm. of iron was placed upon the same filter (an 11 c.m. filter), theory and practice again agreed until the last 20 drops out of a total of 120 drops were reached. These 20 drops, again, filtered rather more quickly than the simple theory would indicate.

Turning now to the application of these results, we see that—

1. If we wish to use the minimum quantity of wash liquid, we must keep the quantity of liquid upon the filter-paper small throughout.

2. The time of working cannot be quickened or delayed by any changes in the method of adding the wash liquid, provided the upper edge of the paper be attended to.

3. If we wish to minimise the drudgery of filtration, we will make each addition as large as possible and allow the precipitate to drain. But the time of washing will not be affected.

Changes of Colour which Mercuric Iodides undergo at Different Temperatures.—D. Gernez.—The author's experiments show that the two varieties of mercuric iodide, when under the influence of refrigerating action, behave as if they were two different bodies, and the quadratic red iodide is not transformed into the orthorhombic yellow iodide. He also finds that these two coloured varieties have clearer and clearer tints as they are cooled—a fact analogous to that recently discovered by M. Moissan with regard to fluorine and sulphur.—*Comptes Rendus*, cxxxvi., No. 14.

NOTICES OF BOOKS.

Determination of Radicles in Carbon Compounds. By H. Meyer. Authorised Translation by J. Bishop Tingle. Second Edition, Re-written. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1903. Pp. xii.—162. 12mo. Illustrated.

Dr. Meyer's "Anleitung zur Quantitativen Bestimmung der Organischen Atomgruppen" met with such success, both in the original language and in translation, that the author was stimulated to prepare this second edition, in which the work has been brought into conformity with the present state of the science by various corrections and additions. In five chapters methods are given, in a compact and useful form, for determination of hydroxyl, of methoxyl, ethoxyl and carboxyl, of carbonyl, and of other groups. Those desirous of making the acquaintance of methods for ascertaining the relative arrangement of the atoms in the molecule of organic bodies will find this little volume a very great help; for a beginner in this study it will be found indispensable.

References to original papers in books and periodicals form an excellent feature of this work, but it is unfortunate that the abbreviations of journal-titles are not more consistently uniform with the list given, and that in the list the requirements of French and German, as respects capitalisation, have not been recognised. This is doubtless due to divided responsibility between author and translator. This small blemish does not, however, detract from the value of the book in the chemical laboratory.

The illustrations, which by the way are not mentioned on the title-page nor in the advertisements, are clear and adequate. H.C.B.

A Handbook of Physics and of Chemistry. By Herbert E. Corbin, B.Sc. (Lond.), &c., and Archibald M. Stewart, B.Sc. (Lond.). With 128 Illustrations. Second Edition. London J. and A. Churchill. 1903. Pp. 438.

Although intended for general use also, the primary object of this book is to enable students to pass the first examination of the Conjoint Examining Board of the Royal Colleges of Physicians and Surgeons.

There is, of course, a good deal to be said in favour of books of this character so long as it is necessary for students to read up for special examinations. They prevent him using up valuable time learning facts which are not wanted in the particular ordeal through which he has to go. Here the necessary knowledge has been abstracted for him from a number of text-books, and has been, so to speak, "peptonised" and served up in an easily assimilable form.

This volume is divided into three principle parts:—(1) Physics, (2) Inorganic Chemistry, and (3) Organic Chemistry; and, considering the size of the volume, a good deal of information has been included in a concise form.

The idea of putting elementary physics first is a good one, as the student will naturally grasp the chemical facts, which are in reality the most important ones, more readily when his mind has been prepared to some extent by acquaintance with some of the fundamental properties of matter. There is an index of eight pages, and the book is well printed and bound.

Die Herstellung von Metallgegenständen auf Elektrolytischem Wege und die Electrogravüre. ("The Production of Metallic Objects Electrolytically and Electroengraving"). By Dr. W. Pfanhauser. Halle-a-S.: Wilhelm Knapp. 1903.

As in the case of the earlier volumes of the series of monographs on applied electrochemistry, this book, which is the fifth volume of the series, will undoubtedly have only

a limited number of readers, having been written by an expert for experts, but all engaged in this branch of technology will find in it much to interest them. Though it aims at being merely an extract, by its continual references to and abstracts of original publications, it will be found specially useful in directing the reader to the best source for any detailed information he may require concerning the extension or perfection of existing plant or works. Owing to the unwillingness of many firms to expose secret methods or details and modifications of processes, these cannot always be described as fully as might be desired, and the same applies to the cost of setting up and running the plant. As far as possible, however, full descriptions are to be found here of all the most modern and important developments of the galvano-plastic process, with abstracts of the specifications of German, English, and American patents relating to this branch of electrochemistry. Short accounts of methods of electrolytic etching and Rieder's process of electro-engraving are added.

Das Weltgesetz des Kleinsten Kraftaufwandes in den Reichen der Natur. I. Band. *In der Mathematik, Physik, und Chemie.* ("The Universal Law of the Least Expenditure of Force in the Realm of Nature." Vol. I. In Mathematics, Physics, and Chemistry). By GUSTAV PORTIG. Stuttgart: Max Kielmann. 1903.

THIS is the first volume of a book which the advertisement tells us is nothing less than epoch-making. It aims at establishing a dualistic theory of the universe as opposed to modern monism. The book is to occupy four volumes, the second dealing with Astronomy, Biology, and the Science of Language; the third with Art and Religion; and the fourth with Philosophy. To attempt a detailed review of this volume would occupy far more space than is at our disposal. Considerable ability is evinced in the treatment of facts and the marshalling of them in array for the purposes of polemics, with an unbounded belief in the theories put forward, and a conviction that from Germany is to be expected the deliverance of the world from the bonds of ignorance, united with a pious dogmatism, which at times produces on the reader an effect startling from its unexpectedness and incongruity. The author is no great respecter of persons or theories other than those he holds. According to him, Hegel is the prince of jugglers, and Leibniz and Kant are not much better. Some parts of his argument are superficial and even trivial, as in the section devoted to mathematics, on the laws of 2 and 3 and their relation to one another, but there is a good deal of shrewd thought exhibited. In places the book is difficult, or rather troublesome, reading; for while no unduly great demand is made on the reasoning powers, the connections between some of the facts and theories are very obscurely stated.

Einrichtungen von Elektrolytischen Laboratorien unter besonderer Berücksichtigung der Bedürfnisse für die Hüttenpraxis. ("The Arrangement of Electrolytic Laboratories, with special reference to the Requirements for Smelting"). By H. NISSENSON. Halle-a-S.: Wilhelm Knapp. 1903.

THIS small book contains descriptions of laboratories devoted to the study and practice of electrolysis, the object of it being to make students and teachers acquainted with the arrangements and appliances in laboratories other than those in which they may happen to have been educated, and at the same time to furnish hints to directors and managers of works, who are supposed not to possess any very extensive scientific knowledge. For this latter purpose a good many elementary facts are detailed in the first part which would probably be perfectly well known by any who are likely to open the book, and might therefore be omitted, or, at any rate, be replaced by references to elementary text-books. In the second part are described some of the most important laboratories in Germany, from which a constant stream of distinguished contributions to our knowledge of electrochemistry is issuing. No English laboratory is included among the thirteen described, and only one American, that of the University of Pennsylvania.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

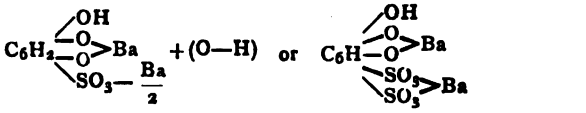
NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 14, April 6, 1903.

Derivatives of Plumbic Acid.—Alb. Colson.—The action of chlorine on lead salts in acid solution apparently takes place according to the equation $2Pb(C_2H_3O_2)_2+2Cl=PbCl_2+Pb(C_2H_3O_2)_4$. This reaction gives a method of preparation for tetraplumbic derivatives which is not only advantageous, but which can be applied in cases where the normal salts and the corresponding tetraplumbic salts cannot be separated by difference of solubility.

Preparation of Zinc Sulphide and of Cadmium Sulphide in the Crystalline Form.—Georges Viard.—By passing the vapour of zinc chloride diluted with carbon dioxide over certain metallic sulphides, a crystalline zinc sulphide is formed by double decomposition. Crystalline cadmium sulphide can be prepared by an exactly similar method. The best metallic sulphides to use are tin protosulphide or antimony sulphide.

Action of Alkaline Earth Bases on the Alkaline Earth Salts of the Pyrogallol Sulphonic Acids.—Marcel Delage.—If to a cold aqueous solution of pyrogallol-monosulphonate or disulphonate of barium, strontium, or calcium, there is added gradually, in contact with air, a solution of baryta, strontia, or chalk, coloured substances are produced. The reactions which take place by the contact of these substances are very complex, and the resulting bodies vary generally with the quantity and the nature of the base added, of the salt used, the more or less long contact, the temperature, the nature of the solvent, &c. The coloured substances, however, seem to belong to one of the two types—



Heat of Combustion of Organic Compounds.—P. Lemoult.—The author's experiments on the heats of combustion of certain carbides verify the two following laws:—(1) That isomerous carbides have the same heat of combustion; (2) the difference between two consecutive homologues is 157 cals. He examines sixty cases, and finds in seven (11 per cent) the approximation between the theoretical and measured quantity of heat is less than $\frac{1}{100}$th; in fifteen (25 per cent) it lies between $\frac{1}{100}$th and $\frac{2}{100}$th; in thirty-eight (64 per cent) it is above this limit. He intends to apply the laws to other series of organic compounds.

Nitrated Cellulose.—Léo Vignon.—A divergence is noticed between the maximum of nitration of cellulose obtained from an estimation of the nitrogen without an estimation of the carbon and hydrogen made by various experimenters and the hypothesis that the cellulose molecule exists in the nitrated derivatives obtained. The author fixes $3(NO_3)$ for one molecule in C_6 as the maximum of nitration of cellulose, and he finds that the nitrated derivative obtained is an oxycellulosic derivative.

No. 15, April 14, 1903.

Catalytic Decomposition of Alcohols by Finely-divided Metals. Formenic Primary Alcohols.—Paul Sabatier and J. B. Senderens.—The authors' experiments show that reduced copper is preferable to nickel, cobalt, or platinum for the decomposition of formenic primary alcohols into hydrogen and the corresponding aldehydes. The use of copper affords, therefore, an advantageous method for the preparation of these latter substances. The only practical difficulty in connection with it is the condensation of the aldehydes; these being very volatile substances, a certain proportion being carried away by the evolved hydrogen. In order to make this error as small as possible, the condensation should take place at the lowest available temperature. The authors are further experimenting on the effect of copper on allyl alcohol, benzyl alcohol, and various secondary and tertiary alcohols.

MISCELLANEOUS.

The British Optical Association.—This Association was formed in 1895, primarily with the idea of the encouragement of the science of optics and the art of its application to the improvement of human vision. It was the first Society in the world to institute optical examinations, and at the present day it is the only body in the United Kingdom holding optical examinations which have for their chief subject that of sight-testing. Membership of the Association is obtainable now only by severe examination. The Council have always had one idea in view—legislative powers—not for one, but for all. This is necessary, firstly, for the protection of the public; secondly, for the protection of qualified optologists. To secure legislation there are four essentials:—(1) Classification; (2) Numbers; (3) Influence and Capital; (4) Education by Examination. Class fication and numbers will result from the realisation of the scheme now put forward. Influence and capital are at the disposal of the Association, and education by examination has been for some time steadily in practice. To secure representation by numbers it will be necessary to increase the present roll of members by the inclusion of nearly all the optical strength of Great Britain, and it is with this idea in view that the Council asks for co-operation. To be eligible for this register the applicant must have been engaged at least five years as master, assistant, or workman in the selling of spectacles or general optical trade, and he must supply a reference from any one wholesale house; the application form, which is supplied by the Association, to be signed by any member of the firm of that house. The charge for enrolment is purely nominal, viz., 3s. per annum. Further particulars and printed forms of application can be obtained from the Secretary, Mr. John H. Sutcliffe, at the Offices of the Association, 17, Shaftesbury Avenue, London, W.

Hydride of Germanium.—E. Voegelen.—By the reduction of a solution of stannic chloride by means of sodium amalgam, the whole of the tin is not only reduced to the state of stannous chloride, but also partially to the metallic state. With chloride of germanium the reaction is analogous. The metal is precipitated on the amalgam in the form of a greyish-brown deposit. The gas given off burns with a bluish-red flame, and gives metallic stains on cold porcelain. The best results are obtained with the help of zinc and sulphuric acid. The germanium mirror has the following properties:—A lustre similar to that of tin, its colour is green by reflection, and a beautiful red by transmitted light; it is more difficult to volatilise in a current of hydrogen than similar deposits of arsenic; it is difficultly soluble in warm hydrochloric acid; when oxidised with concentrated nitric acid, or even when simply heated in the air, it is transformed into the white binoxide of germanium, soluble in hypochlorite of soda. The binoxide of germanium resulting from the oxidation of germanium can be identified easily by solution in hydrochloric acid and precipitation with sulphuretted hydrogen, which gives a white precipitate of sulphide, soluble in sulphide of ammonium. Hydride of germanium behaves like hydride of antimony with nitrate of silver in solution; it forms a black compound of germanium and silver, attackable by concentrated nitric acid, and depositing binoxide of germanium. The analysis of hydride of germanium has been effected by reacting with it either on an aqueous solution of nitrate of silver or on sulphur. The first method of analysis gives figures for the composition of germanide of silver similar to those required by the formula $GeAg_4$. Those obtained by the second process confirm, in an approximate manner, the formula GeH_4. The following is the equation:—$GeH_4 + S_2 = GeS + H_2S$. Estimations effected on extremely small quantities of material give the atomic proportion $\frac{Ge}{H_4} = \frac{1}{3{\cdot}43}$. Attempts to produce a hydride of tin were unsuccessful.—*Zeit. Anorg. Ch.*, vol. xxx., p. 325.

The Solubility of the Hydrates of the Heavy Metals in Soda.—J. Rubenbauer.—The alkaline solutions of the hydrates of glucinum, zinc, tin (stannous), and lead do not contain combinations in any well-defined proportions, the amount of hydrate dissolved depends considerably on the concentration. With hydrate of zinc (and apparently also with hydrate of glucinum) we obtain only slightly stable solutions, which deposit the hydrate spontaneously on concentration. The influence of the concentration of the alkaline lye on the solubility of the hydrates is relatively small with glucinum and tin, more accentuated with lead, and very great with zinc. There is no proportionality between the concentration of the soda and the solubility of the hydrates. With an appropriate concentration of the alkali we can recognise, in most cases, the existence of either a maximum or of a minimum of solubility. In fact, two factors intervene in these phenomena of solubility; on the one hand, the hydrolysis of the salt formed, zincate, glucinate, &c., a hydrolysis which increases with the dilution; on the other hand, the concentration of the alkali, the solubility diminishing as the concentration increases. This latter action is more difficult to explain, and is caused probably by a dehydration of the hydrates (produced by hydrolysis); these latter are precipitated in a less hydrated form.—*Zeit. Anorg. Ch.*, vol. xxx., p. 330.

MEETINGS FOR THE WEEK

Monday, 18th.—Society of Arts, 8. (Cantor Lectures). "Mechanical Road Vehicles," by W. Worby Beaumont Mem.Inst.C.E.

Tuesday, 19th.—Royal Institution, 5. "The Astronomical Influence of the Tides," by Prof. G. H. Darwin, F.R.S.

—— Society of Arts, 4.30. "Mezzotints," by Cyril Davenport, F.S.A.

Wednesday, 20th.—Society of Arts, 8. "Fencing as an Art and as an Historic Sport," by Egerton Castle, M.A.

—— Microscopical, 8. Exhibition of Pond Life.

—— Chemical, 5 30. "Isomeric Partially Racemic Salts containing Quinquevalent Nitrogen—Part XI., Derivatives of *dl*-Methylhydrindamine and *dl*-Neomethylhydrindamine—Isomeric Salts of the Type $NR_1R_2H_2$," by G. Tattersall and F. S. Kipping. "The Conditions of Decomposition of Ammonium Nitrite," by V. H. Veley. "Note on the Action of Methylamine on Chromic Chloride," by W. R. Lang and E. H. Jolliffe. "The Action of Liquefied Ammonia on Chromium Chloride," by W. R. Lang and C. M. Carson.

Thursday, 21st.—Royal Institution, 5. "Proteid Digestion in Plants," by Prof. Sidney H. Vines, F.R.S., &c. by Sir James Charles Lyall.

Friday, 22nd.—Royal Institution, 9. "Dictionaries," by J. A. H. Murray, M.A., Litt.D., &c.

Saturday, 23rd.—Royal Institution, 3. "Evolution of Music" (with Musical Illustrations), by F. Corder.

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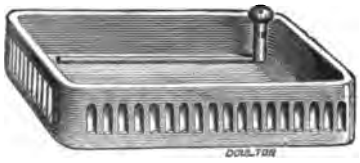

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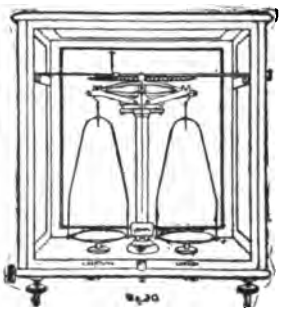

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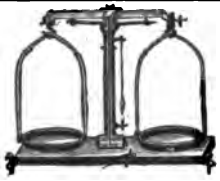

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THE CHEMICAL NEWS.

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CERTAIN PROPERTIES OF THE EMANATIONS OF RADIUM.

By Sir WILLIAM CROOKES, F.R.S., &c.

THE emanations from radium are of three kinds. One set is the same as the cathode stream, now identified with free electrons—atoms of electricity projected into space apart from gross matter—identical with "matter in the fourth or ultra-gaseous state," Kelvin's "satellites," Thomson's "corpuscles" or "particles"; disembodied ionic charges, retaining individuality and identity.

Electrons are deviable in a magnetic field. They are shot from radium with a velocity of about two-thirds that of light, but are gradually obstructed by collisions with air atoms.

Another set of emanations from radium are not affected by an ordinarily powerful magnetic field, and are incapable of passing through very thin material obstructions. They have about one thousand times the energy of that radiated by the deflectable emanations. They render air a conductor and act strongly on a photographic plate. These are the positively electrified atoms. Their mass is enormous in comparison with that of the electrons.

A third kind of emanation is also produced by radium. Besides the highly penetrating rays which are deflected by a magnet, there are other very penetrating rays which are not at all affected by magnetism. These always accompany the other emanations, and are Röntgen rays —ether vibrations—produced as secondary phenomena by the sudden arrest of velocity of the electrons by solid matter, producing a series of Stokesian "pulses" or explosive ether waves shot into space. These rays chiefly affect a barium platinocyanide screen, and only in a much feebler degree zinc sulphide.

Both Röntgen rays and electrons act on a photographic plate, and produce images of metal and other substances enclosed in wood and leather, and shadows of bodies on a barium platinocyanide screen. Electrons are much less penetrating than Röntgen rays, and will not, for instance, show easily the bones of the hand. A photograph of a closed case of instruments is taken by the radium emanations in three days, and one of the same case by Röntgen rays in three minutes. The resemblance between the two pictures is slight, and the differences great.

The action of these emanations on phosphorescent screens is different. The deflectable emanations affect a screen of barium platinocyanide strongly, but one of Sidot's zinc sulphide only slightly. On the other hand, the heavy, massive, non-deflectable positive atoms affect the zinc sulphide screen strongly, and the barium platinocyanide screen in a much less degree.

If a solid piece of radium nitrate is brought near the screen, and the surface examined with a pocket lens magnifying about 20 diameters, scintillating spots are seen to be sparsely scattered over the surface. On bringing the radium nearer the screen the scintillations become more numerous and brighter, until when close together the flashes follow each other so quickly that the surface looks like a turbulent luminous sea.

It seems probable that in these phenomena we are actually witnessing the bombardment of the screen by the positive atoms hurled off by radium with a velocity of the order of that of light: each scintillation rendering visible an impact on the screen, and becoming apparent only by the enormous extent of lateral disturbance produced by its impact. Just as individual drops of rain falling on a still pool are not seen as such, but by reason of the splash they make on impact, and the ripples and waves they produce in ever-widening circles.

The Spinthariscope.

A convenient way to show these scintillations is to fit the blende screen at the end of a brass tube with a speck of radium salt in front of it and about a millimetre off, and to have a lens at the other end. Focussing, which must be accurately effected to see the best effects, is done by drawing the lens tube in or out. I propose to call this little instrument the "Spinthariscope," from the Greek word σπινθαρίς,* a scintillation.

RADIO-ACTIVE LEAD AS A PRIMARILY ACTIVE SUBSTANCE.

By K. A. HOFMANN and V. WÖLFL.

CONTINUING our earlier communications† we must next call attention to the fact that from different uranium minerals, especially from pitchblende, by ordinary analytical methods, radio-active lead was obtained, its activity originally being about equal to that of the uranium. A decided increase could be obtained, firstly, by extracting the chloride with dilute hydrochloric acid or a slightly acidulated solution of sodium chloride, by which means the activity is concentrated in the most soluble portions, or secondly, and better, by the partial decomposition of the double salt with sodium thiosulphate (*Berichte*, 1902, xxxv., 1453) in aqueous solution, when the sulphides first separating out are most active. By these methods preparations are obtained which through a single screen of quantitative filter-paper affect the electroscope 1000 times as strongly as uranous-uranic oxide, but still contain much ordinary lead. To remove this, the enriched chloride, obtained as described above, is digested with 4 per cent hydrochloric acid, and then a considerable excess of sulphuric acid is added, and alcohol until the liquid contains 30 per cent of it. After once repeating this treatment the residue has an activity (α and β) scarcely greater than that of uranous-uranic oxide, while from the the filtrate, by addition of ammonia and ammonium sulphide, a brown sulphide separates out, which, when dried on the filter, immediately discharges an Elster-Geitel electroscope at a distance of 3 c.m. If, instead of using this method, the sulphate is extracted with dilute aqueous sulphuric acid, the result is only small, as the active sulphate either differs only slightly from ordinary lead sulphate as regards solubility in water, or else is retained by the lead sulphate (especially when this is present in large quantity).

The treatment here given of the chloride with hydrochloric acid and alcoholic sulphuric acid recalls Classen's ("Select Methods of Analytical Chemistry," I., 1901, 106) directions for separating lead and bismuth, so that it might appear that the active constituent is closely allied to bismuth. But in contradistinction to bismuth sulphide, the ammonium sulphide precipitate mentioned above is decomposed by dilute hydrochloric acid at the ordinary temperature, and after evaporation to dryness on the water-bath the chloride is completely dissolved in 0·3 per cent hydrochloric acid. From the solution by means of sulphuretted hydrogen a blackish-brown precipitate is

* Ἐνθ ἐκ νηὸς ὄρουσεν ἄναξ, ἑκάεργος Ἀπόλλων,
ἀστὴρ εἰδόμενος, μέσῳ ἤματι τοῦ δ' ἀπὸ πολλαὶ
σπινθαρίδες πωτῶντο, σέλας δ' εἶεν οὐρανὸν ἷκεν'.

(Here from the ship leaped the far-darting Lord Apollo, like a star at midday, while from him flitted scintillations of fire, and the brilliancy reached to heaven).—HOMER'S *Hymn to Apollo*, lines 440—442.

† *Berichte*, 1900, xxxiii., 3126; 1901, xxxiv., 8, 407, 907, 3033, 3970; 1902, xxxv., 1453. See also K. Hofmann, "Radio-active Substances according to the Present State of Scientific Knowledge," J. A. Barth, Leipsig. 1903.

obtained, which is insoluble in yellow ammonium sulphide, but is very rapidly decomposed by 20 per cent cold hydrochloric acid. The resulting chloride is colourless, crystallises in flat, glittering, double refracting pointed prisms, with direct extinction and beautiful polarisation colours; it differs from polonium in being perfectly soluble in 0·3 per cent hydrochloric acid, gives with potassium iodide a dark yellow (not red, *c.f.* bismuth) iodide, forms white crystals with dilute aqueous sulphuric acid, and on addition of excess of ammonia gives a white turbidity, which on heating forms small glittering white crystals. Hence the substance must first be compared with lead, even if in the precipitation with hydrochloric acid and alcoholic sulphuric acid mentioned above ordinary lead should separate out quantitatively.

The yellowish oxide, which glitters when dry, discharges the electroscope visibly even when present in very small quantity (0·01 gr.), and at a great distance (3 c.m.), and strongly blackens the photographic plate through a double layer of black paper in twenty minutes. Sidot's blende and barium platinum cyanide are rendered highly luminous.

The chloride may be hydrolysed to a very small extent, so that after repeated evaporation to dryness on the water-bath, on extraction with pure hot water, the greatest part of the active constituent remains behind, but it dissolves in 0·3 per cent hydrochloric acid after protracted heating, and is not precipitated from such solution either by water or by alcohol (up to 40 per cent). In this way bismuth (polonium) may be completely, and ordinary lead almost entirely, removed, but the very strongly α- and β-active preparations thus obtained are usually adulterated by an unknown constituent, which has already been mentioned (*Berichte*, 1901, xxxiv., 908, 3036); this colours the chloride pink and the sulphate red at 400°.

Unlike ordinary lead, the active substance is to a very large extent soluble in ammonium carbonate; by the action of oxidising agents, *e.g.*, hydrogen peroxide or bromine, it is concentrated from alkaline solution in the first precipitate.

In the radio-lead preparations, obtained by the methods described above, it may be proved with certainty that they possess primary and not induced activity. This may be deduced from the fact that the sulphate, sulphide, and chloride, after being kept for a year in the dry state, show not a diminished, but in many cases an increased activity towards the electroscope and the photographic plate. Referring to Rutherford's (*Phil. Mag.*, 1903, [6], v., 177) work, for the future, for the sake of brevity of expression, the easily absorbed activity, which is observed by means of the electroscope, and thus increases the conductivity of the air, will be denoted by α, and the activity, which penetrates black paper or aluminium foil, and is demonstrable on the photographic plate, by β.

In contrast to the polonium preparations, whose β-activity very soon disappears, a characteristic property of the radio-lead in the different compounds is the persistence of the β- as well as the α-activity, so that between the poles of a strong magnet, besides the α-rays which are either not capable of deflection, or are only slightly deflected in the opposite direction (Rutherford, *loc. cit.*), other strongly deflected rays are always visible on the plate. Nevertheless, as will be shown later, the activity of the lead preparations may be temporarily almost entirely removed, and augmented very considerably by intense cathode rays (K. Hofmann, A. Korn, E. Strauss, *Berichte*, 1901, xxxiv., 407; 1902, xxxv., 1455). According to the most recent work by A. Korn and E. Strauss, which appeared in *Wiedemann's Annalen der Physik*, the β-activity of the sulphate is increased three-fold (as measured by a selenium cell) by cathode rays and also by canal rays, but the α-activity is appreciably strengthened only when it had been previously diminished to a lower value than the normal by chemical changes. This occurs, for instance, on evaporating with sulphuric acid, and on heating to a dull red heat for some hours; the duration of discharge of the original substance is to that of the substance thus treated as forty-five seconds to two minutes. Also by repeated evaporation of the sulphide with hydrochloric acid, solution and re-precipitation with sulphuretted hydrogen, the α-action is temporarily diminished, the duration of discharge prolonged from 65″ to 2′ 15″. After being kept for some weeks the earlier strength is recovered. The β function remains almost unaltered during such changes, which are not accompanied by any separation; though it also may be removed (see later), it is restored in a shorter time (about five days.

The radio-lead salts, therefore, contain a principle giving rise to activity.

As a characteristic of the α-activity the following fact must be mentioned, viz., that by heavy metals of the most different natures the α agent may be removed from the solutions of radio-lead chloride without even a trace of a precipitate being visible on the pieces of metal. When, for example, an aqueous solution of the chloride (α-strength = 20 × uranium) was evaporated on the water-bath four times in a clean platinum dish and then the salt removed, this was decidedly weaker than uranium, though after three weeks the chloride had again attained its former α-intensity (20 × uranium). On the other hand, the platinum dish even after being washed and dried with filter-paper, discharged the end of the wire of the Elster-Geitel electroscope in 5″ at a distance of 1 c.m., but after ignition for a quarter of an hour it became quite inactive.

The transference of the α agent from the solution to metals may be observed still better if the latter in the form of little clean strips are suspended in a large quantity (10 litres) of an aqueous saturated solution of radio-active lead chloride. Platinium foil in from two to fourteen days (according to the strength of the lead preparation) thus attains an α-activity which is fifty times as great as that of uranium, without even a trace of a separation being visible. Gold and silver are also strongly charged, but palladium is much superior to all noble metals in this respect, without even the slightest deposit appearing on the clean metal. The presence of hydrogen in the palladium appears to play no part in this characteristic behaviour.

The α-action thus induced persists at the ordinary temperature for months, and is not removed by washing with water and rubbing with paper. It disappears, however, at a red heat in a few minutes.

When the noble metals are immersed in the radio-lead solution the β-activity is taken up to a considerable extent by palladium, but only slightly by platinum. After ignition for half-an-hour it does not disappear, but it is destroyed if the metal is kept for four weeks.

A crystal of bismuth was clean after remaining in the lead chloride solution for eight days, and then appeared only feebly α- and β-active, which shows clearly the difference between it and polonium, for in solutions of the latter, according to Marckwald (*Berichte*, 1902, xxxv., 2285), a little stick of bismuth was covered with a black exceedingly strongly α-active deposit.

A lead wire* became strongly α- and less strongly β-active also in the active lead chloride solution, and retained this property after being thoroughly boiled with water and rubbed with filter-paper. By fusion this lead becomes (α) inactive towards the electroscope, but still strongly blackens the photographic plate through opaque paper; this power disappears spontaneously after some weeks.

If a lead wire is immersed to only one-third of its length in the active lead chloride solution, after three weeks the first one-third appears very strongly both α- and β-active; but the parts outside the liquid are far less (α and β) active, and the activity completely disappears towards the free end. The intensity of the α-activity taken up by

* H. Becquerel (*Comptes Rendus*, 1901, cxxxii., 371) was able to render pieces of lead strongly active by induction by means of a radium salt.

the metals mentioned is much greater in the cases of palladium, platinum, silver, and lead than that of the radio-lead salt used for the research. This discharged the electroscope only twice as quickly as uranium, but the palladium foil at a distance of 3 c.m. caused the collapse of the leaves from 120 to 30 volts in one second. The induced silver and lead wire also discharged the electroscope 125 times as quickly as uranium oxide, after being rubbed with filter-paper.

From these researches we can conjecture that the α-agent is a fine material, perhaps consisting of positively charged fragments in Rutherford's (*Phil. Mag.*, [6], v., 177—187) sense, which are occluded like hydrogen by metals, and so may accumulate from a lower to a higher concentration.

The conclusion that in these researches the substance yielding the activity, *i.e.*, the radio-lead itself, is not separated, follows from the fact that the immersed metals remain clean, and are not weakened by rubbing with filter-paper, as well as from the fact that after ignition or being kept for a long time, unlike the radio-lead preparations themselves, they completely lose the α- and β-activity. The *a* agent removed from the solution is again produced in the liquid after some days by the dissolved salt, as special experiments showed.

In order to transfer the β-activity from the radio-lead to other metals to an appreciable extent, an intimate contact of the substances is generally necessary (see above), as, for example, results when they are in the same solution. The platinum metals, especially palladium, platinum, rhodium, and iridium in particular, are separated out in a very strongly α- and β-active condition, after keeping their chlorides in a solution of radio-active lead chloride (about 20 grms. r-$PbCl_2$ to 1 grm. $PtCl_6H_2$) for three weeks by warming with formalin. For instance, the lead chloride used discharged the electroscope from 120 volts to 30 volts in one minute, as compared with uranic-uranous oxide in 1'30", but the iridium which had been rendered active by it discharged the electroscope in five seconds. The platinum metals thus rendered active by induction acted very strongly on the photographic plate through black paper; iridium, for example, fifty times more strongly than uranic-uranous oxide, even if the inducing radio lead chloride only possessed an activity three times as strong as that of uranium. By strongly igniting, the α-activity disappears, but not the β.

Gold, as gold chloride, became very strongly active in four weeks (100 times as strongly as uranium) by induction with thirty times the quantity of lead nitrate, which affected the electroscope twice as strongly as uranium, but after being exposed for fourteen hours to the photographic plate covered with black paper it gave no result, and hence was inactive as regards the β-function. Thus the noble metals possess very different powers of taking up the β-activity.

By acting inductively on other substances the lead preparations themselves were temporarily weakened. This occurred in an especially noteworthy manner when a large quantity of ordinary inactive bismuth (about 5 grms.) was mixed with moderately strong radio-lead salt (0·3 grm.). The mixture was evaporated with sulphuric acid, and after three weeks converted into sulphide by potassium sulphide; this was then decomposed by hydrochloric acid, the lead chloride, dissolved in almost pure water, separated from the bismuth oxychloride, and precipitated as sulphide. This lead sulphide after being dried was scarcely active towards either the plate or electroscope, but, after being kept, in six days it regained about two-thirds of its β- and one-third of its α-activity. The bismuth was at first feebly α- and β-active, but after fractional precipitation with water from its solution in hydrochloric acid the first portions separated showed greatly increased activity in both functions.

Hence bismuth is able temporarily to remove the activity from active lead salts (according to experiments which were carried out together with Herr Gonder). On the other hand, it was not found possible conversely to deprive polonium preparations, which are only α-active, of their activity by lead salts (inactive) by the method given above. The bismuth (polonium) retained its α-activity, and there was no indication of its being transformed into β-activity. It certainly seemed *per se* most probable that by mixing much lead salt (inactive) with very strongly α-active polonium, the β-activity, always characteristic of radio-lead salts, would appear. In spite of many experiments this was never observed, from which again the principal difference between radio-lead salts and polonium preparations may be inferred.

Metallic lead on being immersed for twelve hours in a hydrochloric acid polonium chloride solution becomes very strongly α-active, but perhaps, as in Marckwald's (*Berichte*, 1902, xxxv., 2285) experiment, here also it is a question of the precipitation of active metal.

Palladium (*c.f.* Giesel, *Berichte*, 1903, xxxvi., 729), platinum, and silver wire became so strongly α active by means of only α-active polonium solution that they discharged the electroscope in a few seconds, and, especially in the case of palladium, excited Sidot's blende to decided phosphorescence. No decrease of activity was observed in these wires when they were kept for six weeks in a vacuum or in closed tubes. By strongly igniting before the blowpipe this activity disappeared, which, as the persistence of an effect through black paper on the plate showed, consisted only of the easily absorbed α agent. Thus the β-activity had retained its character here also without having experienced any qualitative change in its transference to other metals.

The essential results of this research may finally be given as follows:—There exists a substance analytically closely allied to ordinary inactive lead, but separable from it, which is very strongly primarily active, and produces both α- and β-activity, and hence can act strongly on other metals by induction, whether these are kept as salts in the same solution with the radio-lead chloride, or whether as clean chemically unaltered fragments they are exposed to the influence of the primary agent.—*Berichte der Deutsch. Chem. Gesell.*, 1903, xxxvi., 1040.

THE DETECTION OF SMALL QUANTITIES OF MALTOSE IN THE PRESENCE OF GLUCOSE.

By L. GRIMBERT.

THE estimation of a mixture of glucose and maltose does not offer any great difficulty when these two sugars are present in such proportions that the polarimetric deviation and the reducing action can be measured with certainty. The same is not the case, however, when one of the two bodies only is present in very small amount in the mixture. In such a case their transformation into osazone may be of great service.

For this purpose I have endeavoured to make use of the research published by MM. R. Lépine and Boulud in the *Comptes Rendus de la Société de Biologie* of the 7th December, 1901. Their method consists of treating the osazone formed with ether; the maltosazone only went into solution. The evaporated ether left a residue that could be crystallised in warm water; the dried crystals fused at 206°.

I wished, first of all, to verify the value of the method by working on a maltosazone, produced from pure maltose, which had been subjected to two crystallisations in alcohol at 96°, and, to my great astonishment, I found that maltosazone is as insoluble in ether as is glucosazone, which rendered all idea of separation impossible. I must also accept with great reserve the fusion point obtained by the above-mentioned chemists, as they do not give any details as to their method of operating. Now, as has been said truly by L. Maquenne ("Les Sucres et leur Principaux Dérivés," p. 257, 1900), "the fusion-point of

the osazones is not distinctly marked, and may vary even 20° according to the time taken to fuse the material."

Thus, by using an oil-bath and heating rapidly, as recommended by Fischer, I have seen maltosazone commence to decompose at about 180°, while on Maquenne's block, that is by Bertrand's so-called instantaneous method of fusion, a constant fusing-point of 196—198° can be obtained.

Glucose, of which the fusing-point is given at 205°, only fuses at 230—232°, according to Bertrand.

I have therefore taken up the examination of maltosazone and compared its properties with those of glucosazone with the object of finding a means of separating the two.

Maltosazone.—Solutions of pure maltose, more and more dilute, are treated with 1 c.c. of freshly re-distilled phenylhydrazine and 1 c.c. of acetic acid, for each 20 c.c., then heated on the water-bath for one hour. No crystallisation takes place when warm, and the osazone is only formed on cooling.

The reaction is still distinct in a solution containing only $\frac{1}{1000}$th part of maltose; beyond that point I obtained only negative results. In this respect the detection of maltose by phenylhydrazine is less sensitive than that of glucose, of which one part in 20,000 can be detected by this method.

If examined under the microscope immediately it has been prepared, maltosazone appears in the form of large, elongated, tabular crystals of a yellow colour. The crystals are smaller when obtained from dilute solutions, while retaining their general appearance. When re-crystallised in water maltosazone gives the same crystals, but they are shorter and grouped together in rosettes or cockades.

Maltosazone is insoluble in benzene and in ether. It dissolves rapidly in warm water and in cold methylic alcohol, in alcohol at 50°, and in a mixture of equal parts of acetone and water.

When purified by treatment with benzene and dried at 100°, it fuses at 196—198° by Bertrand's instantaneous fusion method.

Glucosazone.—Glucose, treated in the same manner, gives a crystallised osazone, which is precipitated when warm, even in solutions containing only $\frac{1}{100}$ of sugar; beyond this limit the precipitation can only be effected by cooling, and the reaction is still distinct with a dilution of 1 part in 20,000.

Under the microscope glucosazone appears in the form of long needles grouped together in branches, or, from dilute solutions, in characteristic bundles.

Like maltosazone, it is insolnble in benzene and in ether; further, it is insoluble in warm water, and in cold methylic alcohol and in dilute acetone. Its fusing-point by Bertrand's method is 230—232°.

Separation of a Mixture of Glucose and Maltose.—The solution containing the two sugars is treated with 1 c.c. of phenylhydrazine and 1 c.c. of glacial acetic acid for each 20 c.c. The whole is boiled for one hour on the water-bath and then allowed to cool completely. The osazone formed is collected and washed with cold water, then, after desiccation, with benzene, until the latter is no longer covered; finally it is dried at 100°. We have then the choice of the two following methods for the separation of the maltosazone:—

1. The purified osazone is triturated in a glass mortar, with the smallest possible quantity of acetone diluted with its own volume of water. Filter. The filtered liquid, left to itself, soon deposits crystals of maltosazone. If we use too much acetone for the amount of maltosazone present in the mixture, the crystallisation will not take place. In such a case it is necessary to let the liquid evaporate in the air in a glass dish until the odour or acetone has disappeared; then pour the cloudy residue into a small test tube and heat gently on the water-bath until it becomes clear; then allow it to cool slowly.

2. The purified osazone is rubbed up with a very small quantity of water and heated on the boiling water-bath for five minutes. Filter rapidly. On cooling, the filtered liquid gives crystals of maltosazone, which can be re-crystallised as has been described above.

By using these two methods concurrently, I have been able to detect maltose distinctly in a solution of $\frac{1}{1000}$th, containing also $\frac{1}{1000}$th part of glucose, and in another solution containing $\frac{1}{2000}$th part of maltose and 1 per cent of glucose.—*Journ. de Pharm. et de Chimie*, Series 7, vol. xvii., No. 5.

LONDON WATER SUPPLY.

REPORT ON THE COMPOSITION AND QUALITY OF DAILY SAMPLES OF THE WATER SUPPLIED TO LONDON FOR THE MONTH ENDING APRIL 30TH, 1903.

By SIR WILLIAM CROOKES, F.R.S.,
and
PROFESSOR DEWAR, F.R.S.

To CHARLES PERRIN, Esq., M.Inst.C.E.,
Water Examiner, Metropolis Water Act, 1871.

London, May 11th, 1903.

SIR,—We submit herewith, at the request of the Directors, the results of our analyses of the 196 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from April 1st to April 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in previous reports.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 196 samples examined by us during the month, all were found to be clear, bright, and well filtered.

The rainfall at Oxford during April was 2·28 inches; the average fall is 1·61 inches, making an excess of 0·67 inch. There was already an excess of 1·05 inches for the first three months of the year, and adding the present one of 0·67 inch we get a total excess of rain of 1·72 inches, or 24·7 per cent on the thirty-five years' average.

It should be pointed out that, with the exception of 0·31 inch, the whole of the rain during April fell on the last six days, so that, generally speaking, April was a dry month.

Our bacteriological examinations of 315 samples taken during the last month have given the results recorded in the following table. Besides these samples we have examined 200 others from special wells, standpipes, &c., making a total of 515 samples in all:—

	Microbes per c.c.
New River, unfiltered (mean of 23 samples) ..	149
New River, filtered (mean of 60 samples) ..	6
Thames, unfiltered (mean of 24 samples) ..	2820
Thames-derived water, from the clear-water wells of eight Thames-derived supplies (mean of 162 samples)	15
Ditto ditto .. .. highest	163
Ditto ditto .. .. lowest	0
River Lea, unfiltered (mean of 23 samples) ..	193
River Lea, from the East London Company's clear-water wells (mean of 23 samples) ..	20

Of the 245 daily samples taken from the filter-wells of the Metropolitan Water Companies, eight samples, or 3·2 per cent, were sterile. There were only five samples, or 2·0 per cent, containing more than 100 microbes, and of

these only one sample contained more than 150 microbes per c.c. The five excess samples contained an average of 122 microbes per c.c.; in March fifteen excess samples contained an average of 136.

In comparison with the month of March analyses, the bacteriological quality of the London Water supply shows considerable improvement, a result which might have been anticipated from the advent of summer, and the improved natural conditions associated with vegetable growth; a state of things which generally improves the quality of the water obtained from such collecting areas as the valleys of the Thames and Lea.

We are, Sir,
Your obedient Servants,
William Crookes.
James Dewar.

PROCEEDINGS OF SOCIETIES.

THE ROYAL SOCIETY.

Conversazione at Burlington House.

The first Conversazione of this season was held at Burlington House on Friday last, May 15th. The guests were received by the President, Sir William Huggins, K.C.B., O.M., &c., and the Society was honoured by the presence of His Royal Highness the Prince of Wales. There was a large number of interesting exhibits comprising a variety of subjects; chemistry, botany, astronomy, electricity, geology, and bacteriology were all well to the fore.

Among the most interesting we may mention an Apparatus for the Detection and Estimation of Minute Quantities of Arsenic in Beer and Brewing Materials, as recommended by a Departmental Committee of the Board of Inland Revenue, exhibited by Prof. T. E. Thorpe, C.B. The apparatus consists of a small glass vessel, open at the bottom, placed within a porous cell, which itself stands in a cylindrical glass vessel surrounded by cold water. A band of platinum encircling the porous cell forms the anode, and the cathode consists of sheet platinum, cone-shaped, suspended in the glass vessel. The electrolyte is dilute sulphuric acid, and the hydrogen and arseniuretted hydrogen generated at the cathode are dried and passed through a heated glass tube, when the arsenic is deposited. The electric current, if taken from the main supply, is reduced to the required intensity by passing through a rheostat consisting of incandescent lamps, and a number of tests can be carried out simultaneously. In the apparatus shown, the charging board was arranged for four tests.

Dr. A. Macfadyen and Mr. S. Rowland showed their Methods of Disintegrating Cells and Micro-organisms and of obtaining their Intracellular Constituents. In the first method the cells are disintegrated by the violent impact of sand particles in the apparatus exhibited. In the second method the use of extraneous disintegrating material is dispensed with, the cells or organisms being disintegrated when in a frozen condition. In the apparatus exhibited the necessary cold and brittleness was secured by the use of liquid air.

Dr. W. Ramsden had some interesting experiments on Surface Membranes, Bubbles, and "Mechanical Coagulation"; and Dr. T. K. Rose showed specimens of Brittle Gold, and photographs illustrating their micro-structure. He finds that the deleterious effects of many impurities are removed by the presence of oxide of copper dissolved in the metal.

Sir William Crookes showed some experiments illustrating the Properties of the Emanations of Radium:—1. Auto-radiographs of Thorium, Uranium, and Radium Minerals. 2. Photographs of Radium Emanations, Deflectable and Non-deflectable by Magnetism. 3. Radiographs of a Closed Case of Instruments; (*a*) by Röntgen Rays; (*b*) by Radium Emanations. 4. Luminous Effects of Radium Emanations; (*a*) Action of Electrons on a Screen of Barium Platino-cyanide; (*b*) Action of Positive Atoms on a Screen of Sidot's Hexagonal Blende. 5. The Photographed Spectrum of Radium. 6. The Spintharioscope.

The auto-radiographs were prepared by placing pieces of the following minerals over a sensitive photographic plate, and leaving them in the dark:—Thorite, torbernite, autunite, alvite, cleveite or broggerite, uranite, arrhenite, yellow wückite, black wückite, euxenite, samarskite, pitchblende, carnotite, chalcolite, fergusonite, orangeite, thorite, and sipilite. After a few days the plate was developed, and all of them were found to have left an impression, the intensity varying with the mineral.

Another interesting item was a cardboard screen, 10 c.m. × 8 c.m., which had been covered with Sidot's hexagonal blende, which is very sensitive to projected atoms but not to electrons; this was painted over with nitrate of radium, the word RADIUM being in the middle; the light from this screen was of considerable intensity, the word RADIUM being very prominent.

Two radiographs were shown of a box of mathematical instruments, one taken by means of Röntgen rays, and the other by placing a piece of nitrate of radium about a foot above the box. In both cases the instruments showed very clearly, but with the radium exposure, though the outlines of the instruments are very sharp, the whole has rather a blurred appearance.

Amongst meteorological instruments, Prof. F. T. Trouton showed a Gravimetric Recording Hygrometer, and an Electrical Dew-point Hygrometer; and Mr. N. Eumorfopoulos exhibited a Callendar's Compensated Barometer in which the readings were multiplied ten times.

Mr. O. W. Richardson showed an Experiment illustrating the Conductivity imparted to a Vacuum by Hot Carbon. The essential part of this apparatus consists of a vacuum tube containing a carbon filament surrounded by a cylindrical electrode from which it is insulated. The carbon filament is heated by an electric current and maintained at a negative potential of 20 volts, when a current of about one hundredth of an ampère passes from the filament to the cylinder. At a somewhat higher temperature the current reaches the value of about half an ampère. There is no current when the filament is positive relative to the cylinder.

Mr. A. E. Tutton, F.R.S., exhibited his "Elasmometer," a new form of interference apparatus for the determination of the elasticity of solid substances. The apparatus is designed to measure the amount of bending suffered by a thin plate of the substance investigated, when supported near its ends against a pair of platinum-iridium knife-edges, under a known weight applied at its centre.

A High Pressure Spark-Gap used in connection with an inductor of the Tesla type, and also in connection with a radiator of Hertzian waves, was shown by the Rev. F. J. Jervis-Smith. The inner coatings of an even number of Leyden jars are connected to the secondary of an induction coil, and to a spark gap, consisting of a thick glass globe, furnished with two platinum-faced balls, adjustable for distance. The outer coatings of the condensers are connected to the primary of an inductor of the Tesla type. The discharge at its terminals is augmented, when the air or gas in the spark-gap globe is subjected to pressure by means of a pump. The shape and character of the gap-spark is greatly modified thereby. The discharge readily perforates and cuts plate-glass, placed in oil, with conductors on each side. The discharge also on striking exhausted bulbs having no terminals produces Röntgen rays of sufficient intensity to produce skiagraphy in a few minutes.

During the evening two demonstrations were given in

the Meeting Room, viz., Lantern slides illustrative of the Nile Dam Works, by Sir Benjamin Baker, K.C.B., and the Analysis of Explosion-flames by Photography, by Prof. Harold B. Dixon, consisting of:—(1) Photographs of explosion flames, taken on very rapidly moving films, showing the genesis of the explosion-wave as the flame travels from the point of ignition, and the influence of reflections from the ends of the tube, and (2) photographs of sound-waves moving through the explosion-flame, by which the approximate temperature of the flame may be calculated.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, May 7th, 1903.

Prof. H. McLeod, F.R.S., Vice-President, in the Chair.

Messrs. F. H. Lees, R. Seligman, D. J. Williams, G. H. Welsford, and E. Gumersall were formally admitted Fellows of the Society.

Certificates were read for the first time in favour of Messrs. Ernest Bury, M.Sc., Brackley Coke Works, Little Hulton; Thomas Campbell, Rosemount Villa, Queens Road, Bradford; Albert James Carrier, B.Sc., 30, Kingwood Road, Bath; Francis Gerald Harmer, Middle Class School, Leeds; Frank William G. King, 15, Almond Road, Lower Tottenham, N.; Charles E. L. Livesey, St. Bede's Grammar School, Bradford; Charles S. Purcell, 37, Acomb Street, Greenheys, Manchester; Dennis Tyrrell, 182, King Street, Norwich.

The Chairman announced that the Council at its meeting that day had awarded the Longstaff Medal to Professor W. J. Pope, F.R.S., for his researches on the stereo-chemistry of compounds of elements other than carbon.

Of the following papers, those marked * were read:—

*64. "*The Action of Ammonia and Organic Bases on Ethyl Esters of Olefinedicarboxylic and Olefine-β-ketocarboxylic Acids.*" (Part II.). By S. Ruhemann.

The olefine-β-ketocarboxylic esters may be obtained by the action of hydrogen chloride not only on the dry mixture of an aldehyde and a β-ketonic ester, but also on their solutions in alcohol or benzene. In some cases this method may be found more convenient than that recommended by Knoevenagel (*Ber.*, 1896, xxix., 172), according to which aldehydes react with β-ketonic esters in the presence of amines to yield either olefine-β- ketonic esters or saturated diketonic esters, the result depending on the temperature. It has now been found that piperidine, when added to a mixture of ethyl benzoylacetate and benzaldehyde, readily induces the formation not of the saturated diketonic ester, but of the olefine-β ketonic ester, ethyl benzylidenebenzoylacetate, $PhCO\cdot C(CO_2Et):CHPh$.

The author also showed that diethylamine effects, although much more slowly than piperidine, the formation of ethyl benzylideneacetoacetate, and that on adding the base to the alcoholic solution of benzaldehyde and ethyl benzoylacetate, the diketonic ester, $PhCH(CHBz\cdot CO_2Et)_2$, is obtained. This ester melts at 115—116°, the fused product solidifies on cooling, and then melts at 129—130°. These results differ from Knoevenagel's observations, according to which ethyl benzylidenebisbenzoylacetate melts at 95°. The difficulty with which ethyl benzoylacetate yields, with aromatic amines, diketonic esters is attributed to the stereo-chemical influence exercised by the phenyl group of the ester.

The esters of benzylidenebenzoylacetic, *m*-nitrobenzylideneacetoacetic, and *m*-nitrobenzylidenebenzoylacetic acids react with benzamidine in a manner similar to ethyl benzylideneacetoacetate (*Trans.*, 1903, lxxxiii., 374); they lose either the acetyl group as ethyl acetate, or the benzoyl group as ethyl benzoate, and yield dihydrodiphenylpyrimidone, previously described (*loc. cit.*), or its nitro-derivative, $CH_2<\begin{matrix}CH(C_6H_4\cdot NO_2)\\CO\text{——}N:CPh\end{matrix}>NH$ (m. p. 192—193°).

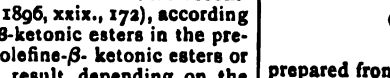
In the case of the action of benzamidine on ethyl benzylidenebenzoylacetate, it has been found that the benzoyl group is only partially removed, and that, besides dihydrodiphenylpyrimidone, its benzoyl derivative, $PhCO\cdot CH<\begin{matrix}CHPh\\CO\cdot N:CPh\end{matrix}>NH$ (m. p. 241—242°), is produced.

Ethyl *m*-nitrobenzylidenemalonate reacts with benzamidine to form $NO_2\cdot C_6H_4\cdot CH<\begin{matrix}CH(CO_2Et)\cdot CO\\NH\text{——}CPh\end{matrix}>N$ (m. p. 181—182°), a compound which, under the influence of ammonia, undergoes a transformation similar to that of ethyl dihydrodiphenylpyrimidonecarboxylate (*loc. cit.*), and yields dihydro-*m*-nitrophenyl-phenylpyrimidone (m. p. 192—193°).

*65. "*Spontaneous Decomposition of Nitrocamphor.*" By T. M. Lowry.

A quantity of nitrocamphor, prepared in 1898 and purified by re-crystallising once from alcohol, was found to have undergone change, although a smaller specimen, which had been further purified and crystallised from benzene, was unaltered; 175 grms. of the changed material gave 85 grms. of crystalline nitrocamphor and 55 grms. of a neutral substance sparingly soluble in spirit. This product, which melted at 256°, dissolved in acetone to the extent of 3·22 grms. in 100 c.c. of solution at 13° and gave $[\alpha]_D = +33°$ in acetone. The substance is not readily acted on either by boiling hydrochloric acid or by alcoholic potash, but is oxidised to camphoric acid by heating with nitric acid at 100°. Molecular weight determinations in boiling benzene solution showed it to be a trimolecular compound, formed by the condensation of three molecules of nitrocamphor. One atom of nitrogen is eliminated in the condensation, probably as a result of the oxidation of 1 mol. of nitrocamphor to camphoric anhydride, and the analytical data agree with those required by the equation $C_8H_{14}<\begin{matrix}CO\\CO\end{matrix}>O + 2C_{10}H_{15}NO_3 = C_{30}H_{42}N_2O_8 + H_2O$.

The substance has therefore the composition of a camphoric ester derived from nitrocamphor or one of its isomerides, and has been found to be identical with a *sesqui-camphorylhydroxylamine*,—



prepared from camphoryl chloride and camphoryloxime.

*66. "*β-Bromo-α'-nitrocamphor and β- and π-Bromocamphoryloximes. The Influence of Impurities in conditioning Isomeric Change.*" By T. M. Lowry.

β-Bromo-α'-nitrocamphor, $C_8H_{13}Br<\begin{matrix}CH\cdot NO_2\\|\\CO\end{matrix}$, prepared by reducing αβ-dibromo-α'-nitrocamphor with alcoholic potash, differs greatly from nitrocamphor, but closely resembles π-bromonitrocamphor.

The *pseudo*-form, $C_8H_{13}Br<\begin{matrix}C:NO_2H\\|\\CO\end{matrix}$, separates in a pure state when a solution of the nitro-compound in benzene or ethyl acetate is slowly evaporated; it melts with slight decomposition at 132°, crystallises again on cooling, and re-melts at or below 96°. The *normal* form was not isolated; a solution in methyl alcohol when slowly evaporated, gave a mixture of the two forms, and a solution in formic acid underwent isomeric change. A mixture of the two forms, obtained by crystallising from hot alcohol or acetic acid, softened at 100°, melted without decomposition at about 114°, and re-melted sharply at 100°; the latter is therefore the temperature at which the solid *pseudo*-form is in stable equilibrium with the liquid mixture. The *potassium* salt of the *pseudo*-

form crystallises from water in glistening needles with $2H_2O$ and is strongly dextrorotatory; the specific rotatory power of the nitro-compound in the salt is $[\alpha]_D = +103°$.

β-Bromocamphoryloxime, $C_8H_{13}Br\begin{<}{C:NOH \\ >O \\ CO}$, prepared by heating the nitro-compound with hydrochloric acid, separates from water in minute needles with $1H_2O$ and melts at 111°. The anhydrous oxime crystallises from benzene in glistening needles; a solution in chloroform saturated at 13° contains 220 grms. in 100 c.c. and gives $[\alpha]_D = +10°$. The *acetyl* derivative crystallises from ethyl alcohol in minute flakes, melts at 112°, and has $[\alpha]_D = +3°$ in acetone. The *benzoyl* derivative crystallises from alcohol in needles, melts at 134°, and has $[\alpha]_D = +11°$ in acetone; unlike nitrocamphor, which gives the camphoryloxime benzoate, the potassium salt of *pseudo*-β-bromonitrocamphor could not be benzoylated by the Schotten-Baumann method.

π-Bromocamphoryloxime, isomeric with the preceding compound, was prepared synthetically from π-bromocamphoric anhydride and hydroxylamine, and is identical with the *iso*-π-bromonitrocamphor which Lapworth (*Trans.*, 1896, lxix., 304) obtained by boiling π-bromonitrocamphor with hydrochloric acid; the acetyl derivative melts at 171° and the *benzoyl* derivative at 185°.

Freshly prepared solutions of β-bromo-α'-nitrocamphor exhibit the phenomenon of mutarotation. A solution in benzene of the *pseudo*-form is at first almost inactive (three specimens gave $[\alpha]_D = +2°$, 0°, and $-4°$), but in the course of two or three days the specific rotatory power becomes constant with $[\alpha]_D = -80°$.

The change of rotatory power is not spontaneous, but is conditioned by the presence of traces of impurity.

Three solutions in benzene of a mixture of normal and *pseudo*-β-bromonitrocamphor were prepared; part of each solution was at once transferred from the graduated flask to a tube and examined in the polarimeter, and in each case a gradual change of rotatory power from $-72°$ to $-80°$ was observed during the first twenty-four hours; a few days later, the remainder of the solution in the flask was also transferred to a tube and examined; in one case only had a state of equilibrium been reached, whereas the other two solutions still exhibited their initial rotatory power, although an interval had elapsed three or four times as long as that normally required for the attainment of equilibrium.

Previous observations have shown that normal nitrocamphor does not change spontaneously on dissolution; the facts now recorded show, further, that even when both isomerides are present in solution, equilibrium between them is only established in presence of a catalytic agent, probably an alkali. A final proof is thus afforded that isomeric change, even when it consists merely in the transference of a mobile hydrogen atom, cannot be accomplished within the molecule, and can only be brought about by an intermolecular mechanism, involving at least three molecules and obeying the ordinary laws of chemical change. The phenomena are closely analogous to Baker's observations on the union of hydrogen and oxygen, and are directly opposed to Laar's hypothesis of "tautomerism."

Discussion.

Dr. Lapworth stated that the important observation that mutarotation did not occur in a solution containing a mixture of the two isomeric bromonitrocamphors found a parallel in the behaviour of camphorquinonehydrazone, for the mutarotation of this substance could apparently be arrested by the introduction of an acid at any stage, and therefore when both forms are present.

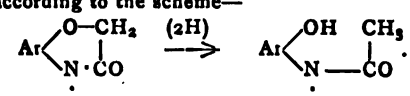
Although Dr. Lowry appeared to conclude that changes of this character were effected by the catalytic agents and would not occur in their absence, yet the usual assumption that the velocity simply becomes immeasurably small in the absence of catalysts seemed to meet the case as well as ever. In the absence of experimental methods for deciding between the two hypotheses, it was impossible to say which view was correct.

Dr. Forster suggested that, in order to avoid confusion arising from the notation of the new derivatives, the name β-bromonitrocamphor should be furnished with an affix indicating the position of the nitro-group, and asked whether Dr. Lowry had obtained fresh chemical evidence leading him to continue the representation of the *pseudo*-nitro-group by Hantzsch's original *iso*nitro-formula, which had been abandoned by chemists generally in favour of the nitronic representation.

In reply, Dr. Lowry stated that the rotatory power of the labile solutions was probably not absolutely constant, as it was impossible, in practice, to prepare absolutely pure solutions; in some cases, an appreciable change could be detected, but in others the rotatory power was quite constant within the limits of experimental error. With regard to the notation of the nitro-derivatives, the nitro-group was probably not in the α- but in the stereoisomeric α'-position. The formula assigned to *pseudo*-nitrocamphor was in accordance with Perkin's observations on the magnetic rotatory power of the substance, which showed that the nitrogen was probably tervalent, and was also analogous to the formula generally adopted for the *iso*oximes.

*67. "*The Electrolytic Reduction of Pheno- and Naphthomorpholones*" By F. H. Lees and F. Shedden.

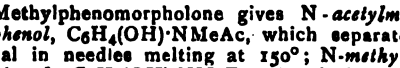
When phenomorpholone, N-methylphenomorpholone, and N-methyl-β naphthomorpholone are electrolytically reduced in sulphuric acid, the first stage of the reduction involves for the most part a disruption of the morpholone ring according to the scheme—



In the case of phenomorpholone, the final products are acetyl *o*-aminophenol, ethyl-*o*-aminophenol, and *isoacetyl-o-aminophenol*, $C_6H_4\begin{<}{OH \\ N{=}C{\cdot}OH}\begin{>}{CH_3}$. The third of these substances crystallises from alcohol in glistening leaflets, and melts at 190° with evolution of water vapour and the simultaneous formation of ethenyl-*o*-aminophenol; this behaviour differentiates it from acetyl-*o*-aminophenol, which melts at 205° and is only partially converted into the ethenyl-base at a temperature approaching 300°. The formation of *iso*acetyl-*o*-aminophenol is probably due to the existence in solution of two desmotropic forms of phenomorpholone, these isomerides each undergoing disruption during reduction in accordance with the foregoing scheme.

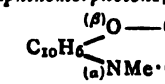
N-Methylphenomorpholone gives N-*acetylmethyl*-*o*-*aminophenol*, $C_6H_4(OH){\cdot}NMeAc$, which separates from methylal in needles melting at 150°; N-*methylethyl*-*o*-*aminophenol*, $C_6H_4(OH){\cdot}NMeEt$, the *hydrochloride* of which forms plates melting at 150°; and N-methylphenomorpholine, $C_6H_4\begin{<}{O{-}CH_2 \\ NMe{\cdot}CH_2}$, which is identical with that obtained by Knorr in another way (*Ber.*, 1889, xxii., 2081).

β-Naphthomorpholone,—

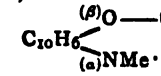


was prepared by the reduction of *α-nitro-β naphthoxyacetic acid*, $C_{10}H_6(NO_2){\cdot}OCH_2{\cdot}CO_2H$, the latter being obtained by two methods:—(1) By nitrating β-naphthoxyacetic acid; (2) by condensing the potassium salts of α-nitro β-naphthol and chloracetic acid in aqueous solution. The nitro-acid separates from acetic acid in yellow prisms and melts at 188—189°; the morpholone obtained from the same solvent forms colourless needles and melts at 215—216°.

N-Methyl-β-naphthomorpholone,—



crystallises from alcohol in long colourless needles melting at 84—85°. When reduced, it gives *N-methylethyl-α-amino-β-naphthol*, $C_{10}H_6(OH)\cdot NMeEt$, and *N-methyl-β-naphthomorpholine*,—



The former distils at 193° (corr.) under 40 m.m. pressure, and is a light yellow oil solidifying on cooling to needles which melt at 25—27°; the *sulphocamphylate*, $C_{13}H_{15}ON\cdot C_9H_{14}O_5S,H_2O$, separates from water in prismatic needles melting at 203—204°; the *hydriodide* crystallises from a mixture of acetone and ether in needles which melt at 183°; the *acetyl* derivative, $C_{13}H_{14}N\cdot OAc$, is a colourless oil boiling at 212—215° (corr.) under 40 m.m. pressure. The morpholine distils at 220—222° under 40 m.m. pressure as a viscid, light-yellow oil, having a blue fluorescence and a faintly basic odour; the *sulphocamphylate*, $C_{13}H_{13}ON\cdot C_9H_{14}O_5S,H_2O$, forms needles melting at 196°; the *methiodide*, $C_{13}H_{13}ON\cdot MeI$, separates in needles melting at 163—164° with evolution of methyl iodide.

DISCUSSION.

Mr. GROVES asked whether the authors had tried to reduce morphine electrolytically, and, if so, whether its morpholine ring underwent disruption in the manner observed with pheno- and naphtho-morpholones.

Mr. LEES, in reply, said that in connection with another investigation he had found that morphine is not changed when subjected to electrolytic reduction. Pheno- and naphtho-morpholones are aryloxy-compounds, whereas in morphine the ether-oxygen atom is attached to a partially reduced aromatic nucleus.

68. "*The Coloured Constituents of Butea Frondosa.*" By E. G. HILL.

The dried and fresh flowers of *Butea frondosa* are extensively used in India for the preparation of a somewhat fugitive yellow dye.

The aqueous extract of the flowers contains an easily decomposable tannin which readily yields phlobaphen; this product, which separates from the solution as a dark, tarry precipitate on boiling with hydrochloric acid, is almost insoluble in warm water, but readily dissolves in alcohol or in aqueous alkalis; from the former solution, it is re precipitated by water, and from the latter by acids. On evaporating the filtrate from the phlobaphen, an odour of charred sugar was noticed, this result suggesting the presence of a glucoside.

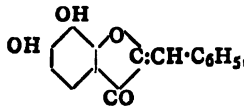
The freshly-prepared extract, when treated with lead acetate, yielded a yellow precipitate of a lead salt which, when suspended in water and decomposed by hydrogen sulphide, furnished a yellow solution, from which a yellow gum was obtained by evaporation. This product, when dissolved in water and extracted with ether, gave a light yellow ethereal solution, from which a semi-fibrous, yellow mass separated. This substance was soluble in hot water, alcohol, or acetic acid, and separated from the last-mentioned solvent in small, lemon-yellow crystals, which gave the reactions of fisetin (compare Perkin and Hummel, *Journ. Soc. Chem. Ind.*, 1895, 459, and Hummel and Cavallo, *Proc.*, 1894, x., 11). At the time this work was carried out, the author had no access to the original papers of the foregoing authors.

After separating the ethereal extract, the aqueous solution was hydrolysed by boiling with dilute hydrochloric acid; this reaction led to the precipitation of phlobaphen, several fractions of the product being collected during evaporation.

These fractions, which are probably different anhydrides of the same tannin, were all readily soluble in alcohol or aqueous alkalis, giving rise to deep reddish-brown solutions; they readily reacted with bromine, evolving hydrogen bromide and giving an amorphous powder lighter in colour than the original substance; this product yielded traces of methyl bromide on treatment with sodium hydroxide solution. Phloroglucinol and protocatechuic acid were obtained from the phlobaphen by fusion with potassium hydroxide.

69. "*Butein.*" (A preliminary notice). By (the late) J. J. HUMMEL and A. G. PERKIN.

The announcement (*Proc.*, vol. xix, p. 126) that a paper by E. G. Hill on "The Coloured Constituents of *Butea frondosa*" would be read at the next meeting of the Society, renders necessary the following note on the investigation of this dyestuff, which is now proceeding. *Butein*, the colouring matter of the flowers of *B. frondosa* (Hummel and Cavallo, *Proc.*, 1894, x., 11), $C_{15}H_{10}O_5$, probably exists in two modifications:—(*a*) Colourless (C=66·62; H=4·32), and (*b*) orange-yellow (C=66·31; H=4·19), which, on fusion with alkali, give resorcinol and protocatechuic acid. The *tribenzoyl* derivative, $C_{15}H_7O_5(C_7H_5O)_3$ (C=74·02; H=4·05), which forms colourless needles (m. p. 155—157°), and the *triacetyl* compound, $C_{15}H_7O_5(C_2H_3O)_3$ (C=63·50; H=4·05) have been studied. The dyeing properties of butein very closely resemble those of benzylideneanhydroglycogallol (Friedländer and Rudt, *Ber.*, 1896, xxix., 879),—



the compound being probably a member of this or some closely allied series. When it is heated with sulphuric acid, a colouring matter is produced, the tinctorial properties of which are somewhat similar to those of alizarin.

70. "*The Relative Affinities of Polybasic Acids.*" By H. M. DAWSON.

The conceptions of avidity, as defined originally by Thomsen, and of affinity, as based on the theory of electrolytic dissociation, are not always identical.

For weak polybasic acids, the relative affinities are determined essentially at all ordinary concentrations by the primary dissociation of a single hydrogen ion, and direct values for the affinities as measured by their base combining powers will be obtained if the quantities of the two acids competing for a base are in the ratio of their molecular and not their equivalent weights.

In the case of strong polybasic acids, the affinity is a complex factor determined by more than one dissociation phenomenon, and a method of viewing such partition phenomena in the case of the stronger polybasic acids is brought forward.

71. "*The Chemical Dynamics of the Reactions between Chlorine and Benzene under the Influence of Different Catalytic Agents and of Light.*" By A. SLATOR.

With a large excess of benzene, the reactions between this hydrocarbon and chlorine are practically limited to the two changes represented by the following equations: $C_6H_6+Cl_2=C_6H_5Cl+HCl$, $C_6H_6+3Cl_2=C_6H_6Cl_6$, the relative amounts of the two chief products depending on the conditions of the experiment.

The velocity of these reactions has been measured under various conditions, especially under the influence of different catalytic agents. A chlorine solution of suitable concentration in dry benzene being employed, the velocity of the reactions is measured by simultaneous titrations of chlorine and hydrogen chloride.

The reaction velocity without a catalytic agent is too small to be measured. Under the influence of iodine chloride, both the substitution and addition reactions take place. The velocity of disappearance of free chlorine is found to be proportional to the chlorine concentration and to the square of the iodine chloride concentration; the

temperature coefficient of the reaction is very small. By investigating the reaction in carbon tetrachloride solution with varying quantities of benzene, it was shown that the velocity is proportional to the concentration of the hydrocarbon. It is found by estimating the hydrogen chloride that 70 per cent of the chlorine takes part in the substitution reaction, whilst the remainder combines additively.

This ratio remains constant, even when the solvent is changed, or the concentration of chlorine, iodine chloride, or benzene varied; it is also only slightly affected by temperature.

With tin tetrachloride and with ferric chloride as catalytic agents, the substitution reaction alone takes place. The accelerating effect due to a mixture of iodine chloride and tin tetrachloride is found to be approximately equal to the sum of that due to each agent acting separately.

Under the influence of light without catalytic agents, the addition reaction alone occurs; under conditions of equal illumination, the velocity of this change is found to be proportional to the square of the chlorine concentration.

72. "*The Diazo-reaction in the Diphenyl Series.* Part I. *On Dianisidine and* 3:3'-*Dichlorobenzidine.*" By J. C. Cain.

On heating aqueous solutions of the diazonium salts prepared from dianisidine and 3:3'-dichlorobenzidine, dark coloured, insoluble, infusible compounds are obtained instead of the expected dihydroxy-derivatives.

The products, which appear to be quinones, agree in composition with the formulæ, $O{:}C_6H_3(OMe){:}C_6H_3(OMe){:}O$ or

$$\begin{matrix} C_6H_3(OMe)\cdot O \\ | \\ C_6H_3(OMe)\cdot O \end{matrix}\Big|,$$

and—

$$O{=}\begin{matrix} C_6H_3Cl{:}C_6H_3Cl{:}O \\ C_6H_3Cl{:}C_6H_3Cl{:}O \end{matrix}, \quad \text{or} \quad O\begin{matrix} C_6H_3Cl\cdot C_6H_3Cl\cdot O \\ C_6H_3Cl\cdot C_6H_3Cl\cdot O \end{matrix}\Big|,$$

the former in each case being the more probable one.

These substances are not affected by the usual reducing agents, but form additive compounds with hydriodic acid and acetic anhydride which are easily decomposed by alkalis, the original compounds being regenerated.

A strong aqueous solution of the diazonium salt from dichlorobenzidine, when heated with twice its volume of concentrated sulphuric acid, yields a very small quantity of 4; 4'-dihydroxy-3:3'-dichlorodiphenyl (m. p. 124°); dianisidine does not give rise to a similar product.

PHYSICAL SOCIETY.

Ordinary Meeting, May 8th, 1903.

Dr. R. T. Glazebrook, F.R.S., President, in the Chair.

Mr. T. H. Blakesley exhibited and described a Spectroscope of Direct Vision, of one kind of glass, and of minimum deviation for every ray that comes into the centre of the field of view.

The refracting angles are such that the cosines of half the refracting angles are equal to half the index of refraction for the ray which is to have no deviation. The first prism is right-angled, and has one angle equal to the refracting angle calculated by the above rule. The second prism and the third possess the refracting angle so obtained, and the fourth is similar to the first. The first and fourth prisms produce the minimum deviation for the selected ray, and operate as reflectors as well. Thus the second prism can be so arranged as to increase the dispersion, but to neutralise the deviation. At this point the ray will be parallel to the incident light but not collinear with it. The third and fourth prisms bring the ray back to collinearity with the incident ray, and each adds its proper dispersion. The first and second are rigidly connected, as are the third and fourth; but these two parts rotate relatively to each other about the symmetrical point, so as to bring any portion of the spectrum into the field of the telescope, which is rigidly connected with the second part, as is the collimator with the first part. The glass selected is heavy and highly dispersive, and the total disperson between the lines A and G is over 18°. The plan adopted can be extended by employing more than one of the arrangements described, in sequence. Mr. Blakesley showed several photographs of the solar spectrum taken with the instrument, and exhibited the iron spectrum to the Fellows present.

Prof. S. P. Thompson congratulated the author upon the design of the instrument and the ingenious principle involved.

Prof. J. D. Everett said that in all previous direct-vision spectroscopes half the prisms increased the dispersion and the other half diminished it; whereas in this instrument all the prisms combined to increase it. He regarded the arrangement as a triumph of inventive skill.

The Chairman said he agreed with the remarks of Prof. Thompson and Prof. Everett. He had had an opportunity of examining the instrument at the National Physical Laboratory, and found the dispersion large and the definition good.

Prof. J. D. Everett read a paper "*On the Mathematics of Bees' Cells.*"

A single cell open at one end has nine faces, three of them rhombuses meeting in a point, and the other six the faces of a hexagonal prism. The pointed ends of one layer of cells fit in between those of an opposite layer, and each rhombus belongs equally to both. The centres of all the rhombuses lie in one plane. If h denote the distance of the plane of either set of apexes from this medial plane, and s the side of a hexagon, the edge of a rhombus is $\sqrt{s^2+h^2}$, the longer diagonal $s\sqrt{3}$, and the shorter $\sqrt{s^2+4h^2}$. The cosines of the angles of a rhombus are $\pm(s^2-2h^2)/(2s^2+2h^2)$, and the cosines of the angles which the line bounding a prism face makes with the prism edges are $\pm s/\sqrt{s^2+h^2}$. Comparing the areas with what they would be if the ends were flat, each rhombus is greater by $\frac{1}{2}\sqrt{3}s\{\sqrt{(s^2+4h^2)}-s\}$, and each prism face is less by $\frac{1}{2}sh$. If the number of cells were infinite, the number of prism walls would be double the number of rhombuses. It may be taken as double. Then, for the greatest economy of material, if a rhombus is n times as thick as a prism wall, we must have $h-\frac{1}{2}n\sqrt{3}\sqrt{s^2+4h^2}$ a maximum, for constant s. This gives $s^2=(12n^2-4)h^2$, leading to $(s^2-2h^2)/2(s^2+h^2)=(2n^2-1)/(4n^2-1)$, $s/\sqrt{s^2+h^2}=1/\sqrt{3(4n^2-1)}$. The usual assumption $n=1$ gives $\pm\frac{1}{3}$ for both these expressions. The average value of n from observations may be taken as $\frac{8}{7}$, giving $\pm\frac{7}{17}$ and $\pm\sqrt{\frac{7}{17}}$ as the values of the cosines. The values $\pm\frac{1}{3}$ for the cosines give what is regarded as the normal type of the bee's cell. The faces of a cell are perpendicular to the six edges of a regular tetrahedron, and the edges of the cell to the faces of the tetrahedron.

Prof. S. P. Thompson said he could not agree with the author that the bees for a given volume of cell wanted to use a minimum of material. He thought the amount of wax necessary was determined by other considerations.

Prof. Everett said he thought the bees were guided by simplicity of construction. If we suppose the bees in the two layers of cells to be arranged like two tiers of cannon balls in the most compact piling, the centres of the bees coinciding with the centres of the balls, each bee takes part in the building of walls between itself and its nearest neighbours, each wall being midway between the two bees, and at right angles to the line joining them. According to the best authorities, there was much irregularity in the construction of bees' cells, but the received form (described in the paper) was a fair average.

Mr. W. A. Price read a note on "*The Coloured Map Problem.*"

He referred to the fact that only four colours are

required to colour a map on the surface of a simply connected region, such as a sphere, in such a way that two countries marching on a boundary line are coloured differently, and exhibited two models of anchor rings the surfaces of which were divided in each case into six sections, each of which marched with the other five; and a model of a ring having a cross-bar or stud, the surface of which was divided into eight sections each of which marched with the other seven. In the case of maps on such surfaces, at least six and eight colours would be required in the respective cases.

Prof. EVERETT said that a proof of the ordinary rule for the number of colours required had been attempted by Prof. Tait in a paper to the Edinburgh Royal Society.

Dr. WATSON read a "*Note on the Construction and Attachment of Galvanometer Mirrors.*"

It has often been pointed out, notably by Lord Rayleigh and Prof. Threlfall, that it is better to increase the sensitiveness of galvanometers and similar instruments by improving the optical system, rather than by pushing the electrical sensitiveness to extreme limits. When working with ordinary silver on glass mirrors difficulties arise in connection with the attachment of the fibre and the fact that it is necessary to use a varnish, which in all cases produces distortion. These difficulties have been overcome by using quartz instead of glass, and platinum instead of silver. A disc of quartz, the diameter of the mirror required, and about 1 m.m. thick, is cut from a rod of the fused material. A small tag of quartz-rod is then fused to the edge. This is for the attachment of the fibre. One surface of the disc is then polished and coated with a platinising solution. The whole is then put into a muffle-furnace and raised to a red heat, when platinum is deposited upon the surface. The disc can then be ground down in thickness from behind until it is as thin as required. This does not produce distortion of the mirror, because of the unstrained condition of the fused quartz. Half-silvered mirrors can be obtained by adjusting the thickness of the coating of the platinising solution. Dr. Watson exhibited several galvanometer mirrors and also larger mirrors on plate glass and lenses.

Mr. C. V. BOYS congratulated the author upon a valuable and interesting paper. The subject of mirrors was one which for many years had troubled and perplexed experimenters. It was surprising that a new method of making mirrors, such as that described in the paper, could have so many advantages over the usual processes.

Mr. J. W. SWAN expressed his interest in the paper, and said he was glad to see that the seed sown by Mr. Boys in the employment of fused quartz was being cultivated to-day. The paper was a valuable practicable contribution. He asked for the composition of the platinising solution.

The CHAIRMAN, in congratulating the author, said he had had an opportunity of discussing with Dr. Watson the uses to which these mirrors might be put, and he had seen their many advantages in a vertical-force magnetograph at the National Physical Laboratory.

Dr. Watson said he thought the composition of the solution was a secret, but it was a comparatively inexpensive liquid, obtainable from Messrs. Johnson and Matthey.

CORRESPONDENCE.

THE ACCURACY OF QUANTITATIVE ANALYSIS.

To the Editor of the Chemical News.

SIR,—It is important that the student of quantitative chemical analysis should get a grasp of the different sources of error which affect his work, and also of the (total) error to be expected in the final result.

On classifying the various errors and considering their magnitudes, we find that most of them may be made, at will, as small as we please, *e.g.*, errors in graduated vessels, errors in calculation, &c.

The errors not within our control are unavoidable errors of manipulation, *e.g.*, errors introduced by weighing (even with correct weights), errors in reading burettes, &c.; the magnitude of these will not, as a rule, be more than one or two parts in a thousand; *i.e.*, the total amount of substance taken as calculated from the results of analysis is too small or too large by one or two parts per thousand, or 0·1—0·2 per cent of the amount really taken.

(It is much preferable to state an error in this way to discussing the error on the percentage of an element in a compound as found by a determination).

This error then of 1—2 parts in a thousand is the only considerable one, and it would seem possible to obtain analyses correct to this limit in gravimetric and also in volumetric analysis. In some cases this accuracy is obtained, but it is doubtful whether, for the ordinary student, such accuracy should be expected or insisted on. Very various views appear to be current among teachers of chemistry with regard to the degree of accuracy it is desirable to demand from the student for a satisfactory analysis, but I think most chemists will agree that it is a matter of some importance.

There are always special considerations in every particular analysis, but, for the average straightforward determination, perhaps we may put the maximum permissible error on the work as about one part in a hundred. It would be of interest to have the views of your readers on this subject, and to learn what the practice is in the various institutions for the instruction of practical chemistry.—I am, &c.,

CHARLES E. FAWSITT.

University of Edinburgh,
May 9th, 1903.

SLIPSHOD METHODS OF OIL AND PAINT ANALYSIS.

To the Editor of the Chemical News.

SIR,—In the CHEMICAL NEWS of May 8th (vol. lxxxvii., p. 217), Mr. J. G. McIntosh takes exception to the recording of the constants of oils, and the method of expressing acid determinations, &c. Although the number of determinations of these "oil-constants" is very great, your correspondent surely goes too far in saying that the data are of "no value whatever except in regard to the particular sample operated on." On the contrary, almost the whole of our knowledge of the chemical and physical characteristics of the various oils, and their similarities and differences, has been obtained by the careful determination of these "constants" on samples of known origin. The analyst necessarily relies largely upon such constants when he reports upon an oil submitted to him for examination.

The figures given in Allen's "Commercial Organic Analysis" are, unless otherwise stated, evidently the collated results of the experience of many observers. The great majority of the readers of Allen's work undoubtedly understand them in this way. Mr. McIntosh admits that two oils of the same nature vary to some extent as regards their characters, and it is the recognition of this fact which gives rise to the recording of—to use a Hibernicism—these variable constants. Assuming the practical work to be properly carried out, there is nothing so valuable as a record of the natural variations to which oils and other natural products are liable. Mr. McIntosh says that there must be a cause for any variation in the composition of various specimens of oils of the same nature, and he adds that "efforts should rather be made to discover the cause of the variation than to register the results . . . ." But is it not a fact that the chief causes of the variations are natural and inherent, being due to differences in the proportions of the proximate constituents, which cannot be either remedied or controlled? Cows' milk is a natural product which varies in composition to a certain, more or

less known, extent, and hundreds of thousands of analyses of milk are on record showing the natural variations of this product; but Mr. McIntosh appears to contend that analysts should neglect the compiling of tables showing the limits of natural variation of milk, and regards them as valueless; apparently arguing that if a specimen of milk is not of strictly normal composition it ought to be, and therefore that its existence should be ignored.

The method of expressing the acidity of a product in terms of so much alkali absorbed has much to recommend it. In many cases it is impossible to record this acidity in terms of the acid present, since the composition, basicity, &c., of the latter are often unknown. Hence the use of the term "acid value" or "acid number," which expresses in a convenient form the amount of caustic potash required to neutralise the acid, namely, the number of milligrammes of KOH for every 1 grm. of the substance under examination. In the case of the Reichert process so generally used for the examination of butter and margarine, it is difficult to see what better method of expressing the results could be devised. The process is an arbitrary one, and the volume of decinormal alkali (not necessarily potash) required for the neutralisation of the volatile acids has to be observed. If from this result the volatile acids are calculated in terms of *butyric acid*, we obtain a figure which may be very easily confused with that for the "soluble acids" of butter, and on this ground alone any such alteration would be disadvantageous.—I am, &c.,

ARNOLD R. TANKARD.

67, Surrey Street, Sheffield.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 16, April 20, 1903.

Specific Heat and Heat of Volatilisation or Fusion of Aniline and certain other Organic Compounds.—M. de Forcrand.—The author re-determines the specific heat and heat of volatilisation or fusion of a number of organic compounds whose thermo-chemical constants are not very definite. This set of researches has in view the verification of the general relation $\frac{L+S}{T} = 30$ (varying from 28 to 32). For aniline the following numbers are found:—

Specific heat in the liquid state	= 0·4838 at 0°
Specific heat in the solid state	= 0·2230 at −15°
Heat of solidification	= 0·0399 cal. at −7·03°
Molecular heat of solidification	= 3·711 cal. at −7·03°

The same observations are also made with nitrobenzene, benzene, and acetic acid.

Sulphur Waters from the Bayen Spring at Bagnères-de-Luchon.—F. Garrigou.—The author makes the following observations as a result of his experiments on the sulphur waters obtained from the Bayen Spring at Bagnères-de-Luchon:—(1) Sulphuretted hydrogen escapes in abundance from the water, because it exists either in the free state or combined in the form of sulphohydrates. (2) After the expulsion of this acid only minute quantities of gas are evolved, proving the very slow decomposition of the remaining monosulphide. (3) By the addition of aluminium sulphate to the remaining water at boiling-point, a rapid evolution of a further quantity of sulphuretted hydrogen takes place, on account of the monosulphide being decomposed into hydrogen sulphide with formation of alumina.

Soluble Cellulose.—Léo Vignon.—By acting on oxycellulose in the cold, aqueous solutions of potash cause the production of a soluble cellulose, which can be precipitated by hydrochloric acid and the chlorides of the alkalis and alkaline earths.

MISCELLANEOUS.

Royal Institution.—On Tuesday next, May 26th, at 5 o'clock, Prof. Edmund J. Garwood delivers the first of two lectures at the Royal Institution on "The Work of Ice as a Geological Agent"; on Thursday, May 28th, at the same hour, Prof. J. A. Fleming commences a course of two lectures on "Electric Resonance and Wireless Telegraphy"; and on Saturday, May 30th, at 3 o'clock, Prof. S. P. Thompson begins a course of two lectures on "The 'De Magnete' and its Author." The Friday Evening Discourse on May 29th will be delivered by His Highness the Prince of Monaco, on "The Progress of Oceanography"; and on June 5th by Prof. H. H. Turner on "The New Star in Gemini." The Extra Discourse on June 19th will be delivered in French by Prof. Pierre Curie on "Radium."

Contributions to Our Knowledge of Cuprous Compounds.—G. Bodlaender and O. Storbeck.—Cuprous chloride, on contact with water, undergoes a decomposition which gives rise on the one hand to hydrochloric acid and suboxide of copper, and on the other hand especially to cupric chloride, with a deposition of metallic copper. This decomposition is retarded by the successive addition of chlorides; a solution containing more than 0·05 molecule of KCl per litre dissolves cuprous chloride without decomposition. In aqueous solution, cuprous chloride is decomposed partially in the form of complex ions. Solutions of chloride of potassium containing 0·05 to 0·4 molecule of the salt per litre dissolve cuprous chloride, with the formation of the compound $CuCl_2K$, while with more concentrated solutions the formula of the complex salt is $CuCl_3K_2$. The molecule of the complex cuprous salts contains certainly only one atom of copper, but the authors have not yet been able to determine definitely whether the cuprous ions were mono- or di-atomic. During the course of their research, the authors have determined a few solubilities. The solubility of cuprous chloride in pure water = 2·851 millimolecules of Cu per litre at about 20°; the solubility in a concentrated solution of KCl, at about 16—20°, is as follows:—One litre of solution of KCl at 0·05, 0·01, 0·2, 1·0, and 2·0 grm.-molecules dissolve 0·002411, 0·004702, 0·009458, 0·0970, and 0·3840 grm.-atoms of copper. *Solubility in* SO_4Cu.—The total quantity of copper which passes into solution is as follows, in grm.-millimolecules per litre:—

Concentration in SO_4Cu ..	0·49375	1·4812	2·4687	2·9625	5·9375
Total copper .	3·125	3·915	4·786	5·193	7·276

In any case, the quantity of copper dissolved in the state of cuprous chloride varies in an irregular fashion as the proportion of cupric sulphate present increases.—*Zeit. Anorg. Ch.*, vol. xxxi., p. 1.

MEETINGS FOR THE WEEK.

MONDAY 25th.—Society of Chemical Industry, 8. "Neatsfoot Oil" and "The Nitric Acid Test for Cotton-seed Oil," by J. H. Coste, F.I.C., and E. T. Shelbourn, F.I.C.

TUESDAY, 26th.—Royal Institution, 5. "The Work of Ice as a Geological Agent," by Prof. Edmund J. Garwood, M.A.

THURSDAY, 28th.—Royal Institution, 5. "Electric Resonance and Wireless Telegraphy," by Prof. J. A. Fleming, F.R.S., &c.

FRIDAY, 29th.—Royal Institution, 9. "The Progress of Oceanography," by His Serene Highness Albert, Prince of Monaco.

SATURDAY, 30th.—Royal Institution, 3. "The 'De Magnete' and its Author," by Prof. S. P. Thompson, F.R.S.

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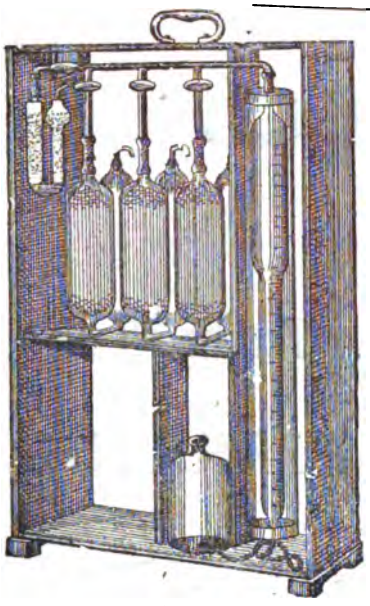

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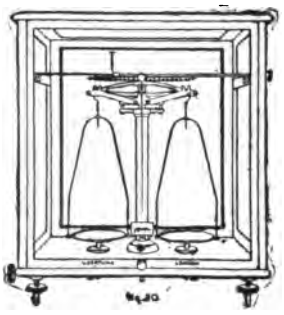

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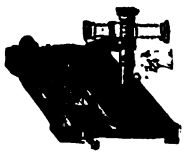

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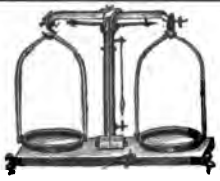

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THE CHEMICAL NEWS.

VOL. LXXXVII., No. 2270.

A NEW CLASS OF ORGANO-TIN COMPOUNDS CONTAINING HALOGENS.*

By WILLIAM J. POPE, F.R.S.,
Professor of Chemistry, Municipal School, Manchester,
and
STANLEY J. PEACHEY.

MOST of the organo-tin compounds which have hitherto been described may be regarded as derived from the hypothetical stannimethane, SnH_4, and, adopting a nomenclature based upon the name of this substance, the simple types of known organo-tin compounds may be described as the tetralkylstannimethanes, the trialkylstannimethyl chlorides, bromides, and iodides, and the dialkylstannimethylene chlorides, bromides, and iodides. The analogy between the various classes of derivatives of stannimethane and of methane is as yet incomplete in that no organo-tin compounds corresponding in constitution to chloroform, bromoform, and iodoform have been described; methods for preparing such derivatives are, however, given in the present paper, so that the analogy of constitution existing between the corresponding classes of alkyl and halogen compounds of carbon and tin is shown to be complete, and of the kind illustrated by the following table:—

$C(CH_3)_4$	Tetramethylmethane.
$C(CH_3)_3I$	Trimethylmethyl iodide.
$C(CH_3)_2I_2$	Dimethylmethylene iodide.
$C(CH_3)I_3$	Methyliodoform.
CI_4	Carbon tetriodide.
$CH_3.CO.OH$	Acetic acid.
$Sn(CH_3)_4$	Tetramethylstannimethylmethane.
$Sn(CH_3)_3I$	Trimethylstannimethyl iodide.
$Sn(CH_3)_2I_2$	Dimethylstannimethylene iodide.
$Sn(CH_3)I_3$	Methylstanniodoform.
SnI_4	Stannic iodide.
$CH_3.SnO.OH$ ..	Methylstannoxylic acid.

Methylstanniodoform, $CH_3.SnI_3$.

Since tetramethylstannimethane is acted upon by iodine with production of trimethylstannimethyl iodide and methyl iodide, in accordance with the following equation:—

$$Sn(CH_3)_4 + I_2 = Sn(CH_3)_3I + CH_3I,$$

it seemed not unlikely that, on replacing the iodine by stannic iodide, the reaction would take the course indicated by the following equation:—

$$Sn(CH_3)_4 + SnI_4 = Sn(CH_3)_3I + Sn(CH_3)I_3.$$

This was found to be the case.

On warming a mixture of tetramethylstannimethane (two parts) and stannic iodide (seven parts) on the water bath, the iodide rapidly dissolves, and, after a few hours' standing at the ordinary temperature, methylstanniodoform crystallises in large straw-coloured prisms; the separation of the latter is rendered more complete by the addition of petroleum ether, and, after filtration, the stanniodoform derivative is purified by crystallisation from ether or light petroleum. It crystallises in long needles or prisms closely resembling iodoform in colour, and melts at 82—84°; it gradually volatilises at 100° and, when slowly heated, distils without decomposition. It is odourless and dissolves very readily in alcohol, acetone, and benzene. The following analytical results were obtained:—

0·3083 gave 0·0254 CO_2 and 0·0172 H_2O. C = 2·24, H = 0·62.

0·2964 required 17·5 × 0·0169 $AgNO_3$ for titration. I = 74·4.

Theory for $Sn(CH_3)I_3$:—C = 2·33, H = 0·58, I = 74·0.

Methylstannoxylic Acid, $CH_3.SnO.OH$.

Methylstanniodoform is insoluble in cold water, but dissolves in boiling water, giving a solution from which the iodoform derivative cannot subsequently be crystallised; as this behaviour should be attributable to the occurrence of hydrolysis in the following sense, $CH_3.SnI_3 + 3H_2O = CH_3.Sn(OH)_3 + 3HI$, methylstanniodoform was evaporated on the water-bath with an aqueous solution of three molecular proportions of soda; as evaporation proceeded, a white precipitate of methylstannoxylic acid was deposited, the reaction being represented by the following equation:—

$$CH_3.SnI_3 + 3NaHO = CH_3.SnO.OH + 3NaI + H_2O.$$

After washing with water, solution in acetic acid, and precipitation with ammonia, the substance gave the following analytical results:—

0·3887 gave 0·0990 CO_2 and 0·0822 H_2O and 0·3532 SnO_2. C = 6·94, H = 2·36, Sn = 71·60.

0·3396 gave 0·0869 CO_2, 0·0800 H_2O, and 0·3024 SnO_2. C = 6·97, H = 2·63, Sn = 70·16.

$CH_3.SnOOH$ requires C = 7·18, H = 2·41, Sn = 71·24.

By the action of methyl iodide on sodium stannite, G. Meyer (*Berichte*, vol. xvi., p. 1439) obtained a white powder in which he made one determination of tin, and which he considered to be probably the acid which we now describe. On repeating Meyer's preparation we found that the substance obtained is identical with the methylstannoxylic acid prepared from methylstanniodoform. To the very scanty description given by Meyer we would add the following.

The acid is conveniently prepared by dissolving stannous chloride (100 grms.) in the minimum quantity of water, and adding concentrated caustic soda solution until the precipitate formed at first just re-dissolves. To the solution thus obtained (300 c.c.), absolute alcohol (200 c.c.) and methyl iodide (90 grms.) are added; the liquid becomes warm and, after two days' repose at the ordinary temperature, is saturated with carbon dioxide, filtered, and evaporated on the water-bath. During the evaporation, methylstannoxylic acid separates in white crystalline crusts, and is obtained in a practically pure condition after filtration and washing with boiling water. The acid is insoluble in water and the ordinary organic solvents, but dissolves slowly in boiling acetic and formic acids. On adding ammonia to the acetic acid solution after dilution with water, no precipitate forms, but on boiling, methylstannoxylic acid separates in a state of purity; the fact that no precipitate occurs until the solution is boiled, indicates the existence in solution of an ortho-acid, $CH_3.Sn(OH)_3$, which is only decomposed on heating. Methylstannoxylic acid decomposes slowly at 120—130°, but no volatile tin compound is evolved; on rapid heating it chars, and, when ignited, smoulders, leaving a residue of stannic oxide. On boiling the acid with dilute caustic potash the greater part dissolves, but the solution never becomes quite clear; when the acid is boiled with stronger potash solution, a rapid evolution of methane occurs, a sublimate of trimethylstannicarbinol, $(CH_3)_3Sn.OH$, forms, and the solution is afterwards found to contain dimethylstannimethylene oxide, $(CH_3)_2SnO$. Lastly, on mixing the acid with solid potash and heating, after the addition of a small quantity of water, methane containing a considerable proportion of tetramethylstannimethane is given off; the latter substance was identified by freezing it out of the gas and determining its boiling-point and behaviour towards iodine. The

* From the Chemical Laboratories, Municipal School of Technology, Manchester. Read before the Royal Society, May 14, 1903.

fact that methylstannoxylic acid is not wholly soluble in dilute potash is attributable to a part of it being decomposed with evolution of methane and production of stannic oxide which remains undissolved by the potash. The evolution of methane which attends the heating of methylstannoxylic acid with potash, is quite analogous to the decomposition which occurs when sodium acetate is heated with soda-lime, whilst the formation of dimethylstannimethylene oxide is analogous to the production of acetone by heating calcium acetate; it is, however, difficult to find analogies for the formation of trimethylstannimethyl alcohol and tetramethylstannimethane during the heating of the stannoxylic acid with potash. The four kinds of change would seem to take place in accordance with the following equations:—

1. $CH_3.SnO.OH = CH_4+SnO_2$.
2. $2CH_3.SnO.OH = (CH_3)_2SnO+SnO_2+H_2O$.
3. $3CH_3.SnO.OH = (CH_3)_3Sn(OH)+2SnO_2+H_2O$.
4. $4CH_3.SnO.OH = (CH_3)_4Sn+3SnO_2+2H_2O$.

Equation 2 is similar to that suggested by Pfeiffer (*Berichte*, vol. xxxv., p. 3303), in order to explain the fact that he obtained diethylstannimethylene oxide instead of ethylstannoxylic acid by the action of ethyl iodide on sodium stannate.

A number of attempts were made to prepare salts of methylstannoxylic acid, but these have been uniformly unsuccessful owing to the very feebly marked acidic characters of the substance. The acidic properties of methylstannoxylic acid are, in fact, so very slight that the substance tends to react in the ortho-form rather than in the stannoxylic condition, although the reverse is true in the case of carboxylic acids. Thus, on treating methylstannoxylic acid with concentrated hydriodic acid, it is immediately converted into methylstanniodoform, so that the reaction, by means of which we first prepared the acid, is a reversible one; since methylstannoxylic acid is very easily prepared in quantity by the action of methyl iodide on alcoholic sodium stannite solution, the most convenient method of preparing the stanniodoform derivative consists in treating methylstannoxylic acid with strong hydriodic acid, and, after filtration, crystallising the product from a mixture of benzene and light petroleum.

Methylstannibromoform, $CH_3.SnBr_3$.

Methylstannoxylic acid dissolves readily in concentrated hydrobromic acid, and on extracting the solution with light petroleum and evaporating the solvent, methylstannibromoform separates. After crystallisation from petroleum it is obtained in the form of long colourless prisms which melt at 50—55° and may be distilled without decomposing. The substance fumes slightly in the air and dissolves to a clear solution in water. Methylstannibromoform is readily soluble in the ordinary organic solvents. The following analytical results were obtained:—

0·4664 gave 0·0563 CO_2 and 0·0382 H_2O. C = 3·29, H = 0·91.
$CH_3.SnBr_3$ requires C = 3·21 and H = 0 80.

Methylstannichloroform, $CH_3.SnCl_3$.

Methylstannoxylic acid dissolves in concentrated hydrochloric acid with evolution of heat, and, after saturating the solution with anhydrous calcium chloride and extracting with benzene, the benzene solution yields a residue when evaporated which slowly crystallises in the desiccator. On gently warming methylstannoxylic acid in a current of dry hydrogen chloride, reaction occurs and methylstannichloroform distils, condensing in the receiver as a colourless crystalline material. The same product is formed on treating the acid with phosphorus trichloride. Methylstannichloroform crystallises from light petroleum in long colourless prisms melting at 105—107° and distils without decomposition at 179—180°. It fumes in the air, dissolves to a clear solution in water, and is very soluble in the ordinary organic solvents.

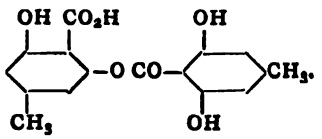
THE CHEMICAL RESEARCHES OF EDWARD SCHUNCK, D.Sc., Ph.D., F.R.S.*

By W. H. PERKIN, Junr., Ph.D., F.R.S.,
Professor of Organic Chemistry, Owens College, Manchester.

In endeavouring to give a brief survey of the work of Dr. Schunck, I should like to call attention to the opening sentences of a paper:—"On some of the Substances contained in the Lichens employed for the preparations of Archil and Cudbear." This important paper was read before the Chemical Society of London on January 4th, 1842, and is published in the first volume of the *Memoirs* of that Society. It begins thus:—"Our knowledge concerning that department of organic chemistry which embraces the colouring matters, and other principles nearly allied to them, is of the most imperfect kind. Though many other branches of organic chemistry have been so thoroughly and accurately investigated, that little or nothing remains to be known concerning them, this may be called an unexplored field." These words and many other statements in the same memoir are very interesting reading, as they show that at that early date the particular section of organic chemistry which deals with colouring matters had special attractions for Dr. Schunck. And indeed this investigation, which he states was commenced at Liebig's suggestion and in the celebrated Giessen laboratory, may be said to have had a fundamental influence on his life's work, because we find that nearly all of the investigations which he subsequently published deal with colouring matters, and especially with the colouring matters which occur in plants.

In the memoir just mentioned, Schunck succeeded in isolating from the lichens of the *Lecanora* and *Variolaria* section, which he was then investigating, a crystalline substance which he named *lecanorin*. Although accurate organic analysis was a matter of considerable difficulty in those days, he was nevertheless successful in correctly determining the composition of this important substance, and the formula $C_{16}H_{14}O_7+2H_2O$ which he gave to lecanorin has been repeatedly confirmed, and is the one in use at the present day.

Rochleder and Heldt, who soon afterwards (in 1843) obtained the same substance from *Evernia prunastri*, altered the name to *lecanoric acid* in order to indicate that it was an acid, and subsequently it was shown by Stenhouse, Hesse, and others, that Schunck's lecanorin is very widely distributed, and occurs as an important constituent of many of the principal lichens. A definite clue to the constitution of lecanoric acid was obtained through the observations of Stenhouse that this substance is hydrolysed on boiling with water, and converted into two molecules of orsellinic acid, a decomposition which clearly proves that the constitution of the acid is represented by the formula—



But the isolation of lecanorin was not the only important discovery which Schunck made in the course of his researches on the lichens. Heeren (in 1830) had made the observation that the lichens *Roccella tinctoria* and *Lecanora tartarea* (which were at that time, and indeed are now, largely used in the preparation of litmus and archil) contain a crystalline substance which he named *erythrin*, on account of its property of yielding a red colouring matter when its solution in ammonia is exposed to the air. He further observed that when boiled with alcohol it is converted into a different crystalline

* Read before the Manchester Literary and Philosophical Society, January 20, 1903. From the *Memoirs and Proceedings of the Manchester Literary and Philosophical Society*, xlvii, Part 3.

substance which does not show this colour reaction, and this he named *pseudoerythrin*. The determination of the nature of these substances was largely due to Schunck, who showed that his lecanorin (lecanoric acid), when boiled with alcohol, is very readily etherified, yielding a substance which is evidently identical with Heeren's pseudoerythrin; this latter substance is therefore, in all probability, the ethylic ester of lecanoric acid. When boiled with water, erythrin is decomposed into orsellinic acid and picroerythrin—a bitter substance which had already been obtained by Heeren—and, since this latter substance, on hydrolysis with lime water, is converted into orsellinic acid and erythrol, it follows that it is an ester derived from *one* molecule of orsellinic acid and *one* molecule of erythrol. The constitution of erythrin itself is thus shown to be that of an ester derived from *two* molecules of orsellinic acid and *one* molecule of erythrol.

The next subject to which Schunck turned his attention was the investigation of the colouring principles of the madder root (*Rubia tinctorum*), and in this field also he obtained remarkable and important results which at once attracted the attention of chemists. The madder root has been employed for dyeing purposes from very early times, but nothing was known as to the active principle contained in it until the year 1826, when Colin and Robiquet succeeded in isolating a colouring matter from it, and to this they gave the name *alizarin*. In 1828 Zenneck published a paper in which he made the remarkable suggestion that the alizarin was not contained in the madder root as such, but was present in combination with sugar or some similar substance. Schunck, in 1847, carefully investigated this matter, and was successful in isolating a bitter substance which he called *rubian*, and he showed that this substance, on boiling with dilute sulphuric acid, is decomposed with formation of alizarin and a sugar, and he was thus able to confirm Zenneck's suggestion.

A few years later (in 1851) Rochleder succeeded in obtaining this glucoside in a crystalline condition, and he then named it *ruberythrinic acid*. Græbe and Liebermann were the first to show that this crystalline ruberythrinic acid, when hydrolysed by boiling with dilute hydrochloric acid, yields, besides alizarin, glucose as the sugary constituent, and they represent the decomposition as taking place according to the equation—

$$C_{26}H_{28}O_{14} + 2H_2O = C_{14}H_8O_4 + 2C_6H_{12}O_6.$$

In 1876 Schunck discovered that when anthraquinone disulphonic acid is fused with soda, a new dihydroxyanthraquinone was formed, which he named *anthraflavic acid*. He subsequently isolated this same substance from the by-products which had accumulated in the manufacture of artificial alizarin, and by fusing anthraflavic acid with potash he obtained a new and very interesting trihydroxyanthraquinone which he called *flavopurpurin*.

Schunck submitted both anthraflavic acid, and flavopurpurin to an exhaustive examination, and converted them into a number of beautifully crystalline derivatives, all of which he obtained in a state of great purity.

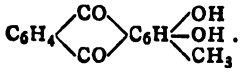
In the year 1876 Schunck associated himself with Roemer, and together they published an important series of papers on some of the di- and tri-hydroxyanthraquinones. They worked out a method for preparing pure purpurin or 1, 2, 4, trihydroxyanthraquinone, and devised an ingenious method for showing the presence of small quantities of alizarin in mixtures of this substance with purpurin. This consists in exposing the alkaline solution of the mixture to the air, when the purpurin is rapidly oxidised and destroyed. Any alizarin present remains unchanged, and can be readily detected by examining the absorption spectrum of the solution.

Schunck and Roemer were also the first to show that purpurin, when heated gradually to 300°, is converted, by a remarkable process of reduction, into chinizarin or 1, 4, dihydroxyanthraquinone.

At as recent a date as 1893 Schunck again took up the investigation of madder root, and in a paper published in conjunction with Marchlewski he describes the isolation of a new glucoside of the formula $C_{21}H_{20}O_9$, which he called *rubiadinglucoside*. This new glucoside crystallises in yellow needles, and is hydrolysed by dilute acids with formation of rubiadin and glucose—

$$C_{21}H_{20}O_9 + H_2O = C_{15}H_{10}O_4 + C_6H_{12}O_6.$$

The constitution of rubiadin was also carefully investigated, and it was found that this substance is a dihydroxymethylanthraquinone or methylpurpuroxanthin of the formula—



We may next notice the important researches which Schunck carried out on the nature of the constituents of the plants *Indigofera tinctoria*, *Isatis tinctoria*, and *Polygonum tinctorium*. All of these yield indigo when their leaves are macerated with water in contact with air, and the first-mentioned is grown in India and China in immense quantities, and serves as the source of nearly all the natural indigo which comes into the market.

It was known from very early times that indigo is not contained as such in the leaves of *Indigofera tinctoria*, and that, in order to produce indigo, it is necessary that the extract of the leaves shall undergo oxidation. In order to explain this, it was at first supposed that the leaves contained indigo white, and that this on oxidation was then converted into indigo. Schunck, however, showed that this could not be the case, because the clear aqueous extract of the leaves which deposits indigo on standing in the air is *acid*, and indigo white is only soluble in *alkaline* aqueous solutions. On investigating this matter, Schunck succeeded in 1853, in extracting from *Isatis tinctoria* an unstable syrupy glucoside which he named *indican*, and which, when warmed with dilute acids in contact with air, readily yielded indigo.

In 1900 Hoogewerff and H. ter Meulen succeeded in obtaining the glucoside in a crystalline condition, but Marchlewski and Radcliffe, in 1898, were the first to give a satisfactory explanation of the composition of this glucoside and its behaviour with acids.

There can be little doubt that Schunck's indican is, in reality, a glucoside of indoxyl, and that, on hydrolysis, it is first converted into glucose and indoxyl, and this latter in contact with air is at once oxidised to indigo. These changes may be represented thus:—

$$C_{14}H_{17}NO_6 + H_2O = C_6H_{12}O_6 + C_8H_7NO \text{ (indoxyl)},$$
$$2C_8H_7NO + O_2 = 2H_2O + C_{16}H_{10}N_2O_2 \text{ (indigo)}.$$

In connection with his researches on indigo, Schunck cultivated for some years the plant *Polygonum tinctorium* in his garden at Kersal, and a short time since he published a very interesting monograph entitled "The action of reagents on the leaves of *Polygonum tinctorium*." This monograph is illustrated with very beautiful coloured plates, which are designed to show the influence of various agents in bringing about the formation of indigo in the leaves of this plant.

During the last few years of his life Dr. Schunck devoted his energies to investigating the great problem of the nature of chlorophyll, the colouring matter which occurs in the green leaves of plants, and which plays such an all-important part in their development. Partly alone and partly in conjunction with Dr. Marchlewski, he published probably the most important papers which have appeared on this difficult subject. These papers contain the description of the best method yet devised for preparing chlorophyll, and there can be no doubt that this method, if it does not yield the pure colouring matter, certainly enables it to be prepared in a much purer condition than it was ever obtained before. In possession of this highly purified product, Schunck and Marchlewski submitted chlorophyll to a careful spectroscopical examination, and at the same time studied its chemical

properties, and made a most valuable investigation into the nature of the highly important products which are obtained when chlorophyll is submitted to the action of reagents. From the point of view of the future possibility of determining the actual constitution of chlorophyll, the experiments on the preparation of phylloxanthin, phyllocyanin, and the beautifully crystalline phyllotaonin, and the examination of their properties and mapping out of their absorption spectra, indicate that there is a possibility of acquiring a clear insight into the nature of the colouring matter at a not far distant date.

But probably the most far-reaching result which was obtained, certainly from a biological point of view, is the proof that *phylloporphyrin*—a crystalline substance which results from the action of alcoholic potash on phyllotaonin—is evidently closely allied to *hæmatoporphyrin*, a substance obtained from the hæmoglobin of the blood. Not only are the spectra of these two substances practically the same, but they also show similar chemical reactions.

It is probable that chlorophyll may play a similar part in the plant to that which hæmoglobin plays in the animal economy, and that its principal function is to convey carbonic acid to the plant in much the same way as hæmoglobin acts as a carrier of oxygen. The proof of the great similarity between chlorophyll and hæmoglobin must go far to break down any sharp line of demarcation which may, by some, still be thought to exist between the animal and vegetable kingdoms.

One thing is most noticeable in all the work which Dr. Schunck did, and that is the extreme care and accuracy with which all his experiments were carried out. The problems which he attempted to solve were among the most difficult in the whole range of organic chemistry, and his results were frequently called in question, but in nearly all cases it was subsequently found that his statements were correct. Anyone who has had the opportunity of examining his magnificent collection of the specimens of the substances he had discovered and investigated during the course of his many researches will, at once, realise the great trouble he always took to obtain everything in its purest possible form.

His work was always a labour of love, and his researches will always remain as models of what skill and perseverance can do in elucidating the most difficult of chemical problems. There can be no doubt that Science, and especially Organic Chemistry, has lost in Dr. Schunck an investigator of the front rank, whose place it will be very difficult to fill.

THE COMPOSITION OF INDIAN LATERITE.

By H. WARTH, D.Sc. (Tübingen),
and
F. J. WARTH, B.Sc. (Lond. and Birmingham).

After the appearance of Mr. T. H. Holland's paper on Laterite, in the *Geological Magazine* for February, 1903 (p. 59), we can at once give the results of our analysis of Indian laterite, without further introductory remarks. They are as follows:—

I.—*Pure Gibbsite from Kodikanal, previously recorded in the Mineralogical Magazine, May*, 1902.

H_2O	33·74
SiO_2	2·78
TiO_2	0·04
CaO	0·20
MgO	0·03
Fe_2O_3	0·44
Al_2O_3	62·80
	100·03

Molecules of water for one molecule of alumina = 3·06, which agrees very closely with the formula of gibbsite, $Al_2O_3+3H_2O$. Specific gravity = 2·42.

II.—*Composition of four Bauxites very rich in Alumina, and containing little Iron, closely resembling the variety called "Wocheinite."*

	2. Kb.	3. Pl.	4. Sr.	5. Rw.
H_2O	26·47	24·00	28·10	26·94
SiO_2	0 93	1·79	2·01	2·35
TiO_2	1·04	3·30	6·49	6 61
CaO	0·36	0·04	0·45	0·15
MgO	—	0·02	—	nil
Fe_2O_3	4 09	6·21	5·48	6·53
Al_2O_3	67·88	64·64	58·23	57·50
	100·77	100 00	100·76	100 08
Molecules of water for one molecule of alumina	2·23	2·11	2·75	2·67

If we take the mean of these figures and calculate the proportion of gibbsite and diaspore ($Al_2O_3H_2O$) in the mixture, we find 72 per cent gibbsite and 28 per cent diaspore. As the proportions vary from 55 per cent to 88 per cent gibbsite, we may roughly say that these rich bauxites or "wocheinites" consist of about three-fourths gibbsite and one-fourth diaspore. Specific gavities:—No. 3 = 2·59; No. 5 = 2·39.

Average of Table III. equals 2·87, which implies 93·5 per cent gibbsite to 6·5 per cent diaspore, with variation from full gibbsite to 60 per cent gibbsite.

These bauxites in blocks and in powder are generally red with a shade of brown; No. 9 is light brown, Nos. 12 and 13 are of a deep red.

The specimens of Indian laterite given in Table IV. are arranged in order of their contents of free alumina, with the exception of the first, the pure gibbsite, which, however, is the richest in alumina if the water is eliminated. The specimens range from 68 per cent of free alumina down to nothing. There is thus every gradation in alumina from nearly theoretically strongest downwards, with no gap to speak of. If, however, we take into consideration the other constituents we find the specimens to fall into four distinct groups.

I. By itself stands the gibbsite from Kodikanal, which is so much free of foreign matter that in the ignited state it contains nearly 95 per cent of aluminium oxide. As stated in the notice in the *Mineralogical Magazine*, this mineral was found to form a deposit of one foot in thickness, consisting of loose crusts or plates which gave the impression of having been extracted from the underlying charnockite. The sp. gr. of this gibbsite was 2·42.

We next come to specimens of the far more extensive and thick-bedded surface deposits, which have hitherto all been classed under the name "laterite."

II. Of these laterites the first four specimens belong to our second group. They agree, as already stated, very well with those richest bauxites which have been given the separate name "wocheinite." They are characterised by their small amount of iron, and have even less silica than the recorded analysis of the celebrated original wocheinite, on an average 1·77 per cent compared with 6·29 per cent at Wochein. On the other hand, they contain much more titanium-dioxide. This large proportion of titanium-dioxide (maximum 6 61 per cent) is very characteristic of the rich bauxites, and a reference to the whole of the tables will show that the titanium-dioxide gradually decreases with the free alumina until there is only 0·01 per cent left. It remains a subject for further enquiry in what form the titanium exists when there is such a large proportion. From the fact of its dissolving when the entire mineral is treated with hot hydrochloric acid, and because there is always enough iron

III.—*Composition of Eight Specimens of Laterites in situ which are Bauxites.*

	6. Marwara.	7. Mahab.	8. Satara.	9. Nilgiris.	10. Nilgiris.	11. Pulsa.	12. Karad.	13. Satara.
H_2O	26·82	24·99	23·88	20·70	19·00	15·87	11·82	14·39
Quartz, SiO_2	—	—	—	—	10·52	—	1·77	—
SiO_2	3·90	0·72	0·37	3·14	0·23	3·56	4·20	0·90
TiO_2	0·38	0·42	4·45	—	0·10	0·13	0·10	1·59
CaO	0·35	0·00	0·86	—	0·40	0·52	nil	0·64
MgO	—	—	—	—	—	trace	trace	0·20
Fe_2O_3	13·75	23·41	26·61	37·88	34·37	47·27	51·25	56·01
Al_2O_3	54·80	50·46	43·83	38·28	35·38	32·65	30·86	26·27
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00
Molecules of water for one molecule of alumina ..	2·80	2·83	3·11	3·09	3·07	2·77	2·19	3·13

IV.—*Composition of Ten Detrital Laterites.*

Locality	14. Belgaum District.	15. Belgaum District.	16. Belgaum District.	17. Jabalpur.	18. Dharwar.	19. Balaghat.	20. Birbhum.	21. Madras neighbourhood.	22. Madras neighbourhood.	23. Madras neighbourhood.
Colour when pulverised ..	Lavender.	Red.	Brownish red.	Red.	Reddish brown.	Brown.	Reddish brown.	Reddish brown.	Brown.	Ochre.
H_2O	13·31	11·42	11·61	10·93	9·64	7·73	9·60	8·66	8·40	10·74
Free quartz, SiO_2	32·24	6·67	8·93	4·53	16·65	39·53	6·29	28·04	32·46	24·39
Combined SiO_2	9·94	13·35	16·69	23·32	14·79	7·96	17·49	14·07	13·33	10·42
TiO_2	0·04	0·25	0·10	0·43	0·02	0·01	0·04	0·01	0·01	0·01
CaO	0·00	nil	0·00	nil	0·04	—	0·03	nil	0·06	0·38
MgO	nil	nil	nil	nil	trace	—	nil	—	—	trace
Fe_2O_3	8·77	41·50	35·69	28·99	35·81	28·38	42·33	30·51	35·34	47·39
Al_2O_3	35·70	26·81	26·98	31·80	23·05	16·39	24·22	18·60	9·93	6·67
Total..	100·00	100·00	100·00	100·00	100·00	100·00	100·00	99·89	99·53	100·00
The same, with the clay calculated separately from the combined silica (kaolin = $Al_2Si_2O_7+2H_2O$).										
Free quartz, SiO_2	32·24	6·67	8·93	4·53	16·65	39·53	6·29	28·07	32·61	24·39
Clay as kaolin, $Al_2Si_2H_4O_9$ ..	21·42	28·77	35·97	50·26	31·88	17·16	37·69	30·33	(27·39)	(20·22)
Balance identical with bauxite. H_2O	10·33	7·41	6·60	3·93	5·20	5·34	4·35	4·45	4·42	7·61
Balance identical with bauxite. TiO_2	0·04	0·25	0·10	0·43	0·02	0·01	0·04	0·01	0·01	0·01
Balance identical with bauxite. CaO	0·00	nil	0·00	nil	0·04	—	0·03	nil	0·06	0·38
Balance identical with bauxite. MgO	nil	nil	nil	nil	trace	—	nil	—	—	trace
Balance identical with bauxite. Fe_2O_3	8·77	41·50	35·69	28·99	35·81	28·38	42·33	30·55	35·51	47·39
Balance identical with bauxite. Al_2O_3	27·20	15·40	12·71	11·86	10·40	9·58	9·27	6·59	—	—
Total..	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00

present, we are inclined to believe that it exists chiefly as ilmenite. As already mentioned, the specimens of this group are mixtures of about three-fourths gibbsite and one-fourth diaspore (by weight). The mean specific gravity of two specimens was 2·49, which is more than that of the Kodikanal gibbsite. Our specimens have also the characteristic pisolitic structure, the globules varying from two to four millimetres in diameter.

III. The third group includes specimens such as geologists have hitherto called high-level laterites. They are bauxites which have formed from highly ferruginous igneous rocks. They belong mostly to the area of the Deccan trap, and we find that the proportion of ferric oxide in these bauxites is in close relation to the proportion of iron in the trap. In the same way the small proportion of iron in the preceding group of wocheinites indicates their origin from less ferruginous, probably gneissic rocks. A glance at the table, Group III., also shows the regularity with which the water decreases in the same order as the alumina, whilst the iron increases simultaneously.

Only in one case, that of No. 13, is there a slight departure from the rule. With the exception of two specimens containing quartz-sand, the quantity of silica is very small. Sample No. 7 contains only 1·14 per cent of substances other than the oxides of iron and aluminium besides water. The ferric oxide appears to be entirely or nearly entirely anhydrous. If this were not the case we should obtain a regularly increasing series for the molecules of water calculated from the total of the water for one molecule of alumina. Although the table shows that the figures vary, there is no great departure from the average, and, as already remarked, the mean of all the eight specimens implies anhydrous ferric oxide and a mixture of 93·5 per cent gibbsite and 6·5 per cent diaspore.

The identity of these high-level laterites with bauxite is also proved by comparison of their composition with that of other bauxites. Our No. 7 is almost identical with the bauxite from near Geissen with which Dr. Max Bauer compared the specimen from Mahé in the Seychelles.

Our specimen No. 9 comes very close to an Irish bauxite which has been analysed by Siemens, who found the following, according to Watts' "Dictionary of Chemistry":—

H_2O	21·5
SiO_2	3·5
TiO_2	2·0
Fe_2O_3	38·0
Al_2O_3	35·0
	100·0

Treated before the blowpipe, all the specimens of group No. III. are infusible, the general character of bauxite. Only in the case of No. 10 there were minute fused spots in small number, and No. 12 showed also traces of fusion, though they were doubtful. This behaviour of No. 10

and No. 12 is no doubt due to these specimens containing more silica than the others and free quartz-grains. This infusibility serves to distinguish the pure bauxities when mixed with Fe_2O_3 from the low-level laterites of the following group, No. IV., which (No. 14 excepted) fused unmistakably. Pure kaolins are also infusible, but if the material is distinctly red from iron the test holds good.

IV. The fourth group includes low-level laterites arranged in order of free alumina which calculation shows them to contain. The presence of free silica in the form of quartz is proved in all cases, and confirms a principal character of these deposits. Whenever distinct quartz-grains are seen in quantity, some of them being at times rather large, we may be sure that we have a detrital or low-level laterite. Besides the quartz-sand there is, however, generally an even larger proportion of clay (on the average 30 per cent of clay and 20 per cent of free quartz). This follows from the proportion of combined silica which is present, and which we may fairly assume to be a constituent of clay. In the table the amount of clay is calculated according to the composition of pure kaolin (kaolin equals SiO_2 46·4 per cent, Al_2O_3 39·7 per cent, H_2O 13·9 per cent). The balance which is left after deducting both free quartz and clay consists of free alumina and ferric oxide with water. This is really the substance of bauxite, with gradually decreasing proportion of alumina. The results of the analysis agree thus remarkably well with the theory according to which the low-level laterite is derived from the high-level laterite, and has during its transport to a new site taken up sand and clay as impurities. Further, the results show that the term laterite has a distinct meaning throughout the many varieties of this rock. Laterite is bauxite in various degrees of purity, from the richest wocheinite down to such specimens in which the free alumina has entirely disappeared. In this sense the specimen from Burmah which has been analysed by Captain James, and recorded in the Manual of the Geological Survey of India, is also still a true laterite. Its composition is similar to that of our two last specimens, No. 22 and No. 23. The sample contained 30·7 per cent quartz and 14·8 per cent clay, and the balance was made up almost completely of ferric oxide (47·4 per cent) with 4·7 per cent water and only 1·3 per cent free alumina.

It cannot be said with certainty what the state of hydration of the alumina is in these detrital laterites. They vary so much in composition, and the colours indicate that the ferric oxide may in some cases be anhydrous and in other cases be present as limonite. Taking all the specimens together, the average composition is such that there is about as much diaspore as there is gibbsite and about as much hematite as there is limonite.

As regards the method of analysis, we found fusion with hydrogen sodium-sulphate the best, if not the only method for all cases. By it the free silica is readily determined as distinct from the combined silica, the iron is obtained in solution, and so is the titanium. With larger proportions of titanium (1 per cent TiO_2 and upwards) we resorted to the method of separation by long-continued boiling, and small proportions of TiO_2 were determined colorimetrically by means of hydrogen peroxide.

To carry out this work at a distance from India would have been impossible, had we not received very liberal help in procuring specimens from a deposit which extends over an area of thousands of square miles. We desire to express our thanks to H.M. Secretary of State for India, through whose kind intervention the bulk of the very richest and most important specimens came into our hands; also to Mr. Edgar Thurston of Madras and to Dr. D. Hooper of Calcutta, who obtained for us the specimens by which the true nature of the high-level laterite was proved for the first time.—*Geological Magazine*, Decade IV., vol. x., p. 154.

ROBERT BOYLE AND THE WORD "BAROMETER."

By H. CARRINGTON BOLTON.

SINCE the publication of my note on the origin of the word barometer (CHEMICAL NEWS, vol. lxxxvii., p. 163) I have received a letter from Mr. A. Lawrence Rotch, of the Blue Hill Observatory, Massachusetts, communicating proof that the Hon. Robert Boyle had invented the term in 1665. The word is to be found in "The General History of the Air," which contains "A Short Account of the Statical Baroscope, Imparted by Mr. Boyle, March 24, 1665."

This "General History of the Air" is mentioned by Prof. G. Hellmann, the eminent bibliographer of meteorology, but he seems to have overlooked the letter quoted.

May 13th, 1903.

CARBONACEOUS SHALE FROM ARGENTINA.

By EDWY G. CLAYTON, F.C.S., F.I.C.

SOME specimens of carbonaceous shale from the Province of Rioja, Argentine Republic, have been examined by the writer. This shale is black, of resinous lustre, slightly greasy to the touch, and exceedingly friable. Heated in the absence of air it yields much gas, readily combustible with a highly luminous flame. The residuum of fixed carbon is not in the form of coke, but is mingled with the mineral matter as a dark grey powder.

Two samples of the shale on analysis gave the following results:—

	A.	B.	Mean of the two analyses.
Specific gravity	1·57	1·75	1·66
Moisture	1·69	1·74	1·72
Volatile combustible matter ..	20 10	17·08	18·59
Fixed carbon	33·86	30 30	32·08
Ash	44·35	50·88	47 61
	100·00	100·00	100 00
Volatile sulphur	1·14	0 63	0·89
Sulphur in ash	0·35	0·35	0·35
Total sulphur	1·49	0·98	1·24
Calorific power (determined approximately by L. Thompson's method)	3300	2750	3025

Certain of the figures are compared below with those in some published analyses (Groves and Thorp, "Chemical Technology," 1889, I., 48—49) of Scotch and Lancashire carbonaceous shales and cannel coal, the latter being included in the table for contrast:—

	Carbonaceous shales.						
		Scotch shales.		Lancs. shales.		Cannel coals.	
	Argentine shale.	Fife "Rums."	From the Stirlingshire coal field.	Birtledean.	Pendleton.	Scotch, Lesmahagow.	Lancashire, Arley.
Spec. grav..	1·66	1·69	2·34	2·39	2·64	1·228	1·27
Volatile matter ..	18·59	26·74	16·53	16·84	22·52	49·34	33·7
Fixed carbon	32·08	20·51	—	—	—	40·97	66·3
Ash	47·61	52·75	83·47	83·16	77·47	6·34	3·6
Sulphur ..	1·24	—	—	—	—	1·35	1·2

These figures well show how, in the shales, the proportions of ash exceed the percentages of fixed carbon and

volatile matter, respectively; the converse applying in the case of the cannel coals, in which the quantities of mineral matter are relatively small.

Chemical Laboratory,
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May 9, 1903.

SEPARATION AND ESTIMATION OF ZINC BY THE ELECTROLYTIC METHOD.

By A. HOLLARD.

Nature of the Electrolyte.

1. Solution of the Double Cyanide of Potassium and Zinc with a Large Excess of Soda.

The principle of the estimation of zinc in solution of the double cyanide of potassium has been known for a long time. The present method has no other object than to regulate the conditions of working more precisely and to show how we have applied this method to the separation of aluminium from zinc, and of zinc from iron.

The solution of sulphate of zinc containing a slight excess of sulphuric acid, is treated with soda until alkaline. Then we add a quantity of soda at 15° B, varying from 15 to 80 c.c., then 10 c.c. of a solution of cyanide of potassium at 20 per cent. Dilute to 300 c.c. The zinc is deposited with a current of 0·1 ampère. The cathode, which is of platinum gauze, has been covered previously by electrolysis, with a layer of copper, to prevent the zinc from adhering to the platinum, as it would always leave traces behind.

The deposit is of a beautiful bluish white colour, and can be obtained very thick without any trouble. In this manner we can easily obtain deposits of 1 grm.

It is quite probable that heavier deposits could be obtained, but we have not tried.

This method is particularly useful for the separation of zinc from aluminium. The alloy of aluminium and zinc—we operate on 1 grm.—is attacked with aqua regia, treated with a mixture of sulphuric acid and water containing 2 c.c. of sulphuric acid at 66° B. After the attack the solution is evaporated until the appearance of voluminous white fumes; the residue, which contains only sulphates and a few drops of free sulphuric acid, is taken up with water; after solution, we add soda and cyanide, as has been described above. The electrolysis is then proceeded with in the manner described.

The separation of zinc and iron is easily effected by the cyanide method; the iron, which should be in the ferric state, is, in fact, insoluble in the presence of a large excess of soda.* As it retains zinc, even after electrolysis, we are obliged to filter off the precipitate of iron as soon as the electrolytic deposition of the zinc is effected, to re-dissolve it in the smallest possible quantity of sulphuric acid, neutralise with soda, and add to this liquid the mother-liquors which have already deposited their zinc on the cathode. The precipitate is left at the bottom of the glass, the electrodes are plunged in, and the electrolysis proceeded with, using the current already mentioned, viz., 0·1 ampère; the cathode is formed of the gauze which has been already used, and which is covered with the first layer of zinc. The remainder of the zinc is then deposited completely, at least when using the proportions of iron and zinc with which we have experimented (see experimental results). Good care must be taken in the separation of the zinc and the iron—as should always be the case when the electrolyte contains a precipitate—to allow the precipitate to settle at the bottom of the glass, and then to push the spiral down to the bottom of the precipitate; in this manner we remove, to a great extent, the metal that might be entangled.

The separation of zinc from nickel cannot be effected by this method; a small quantity of nickel is always deposited with the zinc.

Experimental Results.

The zinc used in these experiments contained 0·18 per cent of lead. The iron used was in the form of ferric sulphate.

	Amount taken. Zn. Grm.	Fe. Grm.	Deposit. Grm.	Fe. Grm.	Zn. Grm.
	With an Excess of 15 c.c. of Soda at 15° B.				
1.	0·3	0·1	0·3014 less 0·0016	gave	0·2998
2.	0·3	0·1	0·3022 ,, 0·0021	,,	0·3001
3.	0·5	0·1	0·4982 ,, 0·0021	,,	0·4961
	With an Excess of 80 c.c. of Soda at 15° B.				
4.	0·2993	—	0·3046 ,, 0·0004	,,	0·3042
5.	0·3019	0·1	0·2962 ,, 0·0016	,,	0·2946
6.	0·5007	0·01	0·5053 ,, 0·0004	,,	0·5049
7.	1·0007	0·1	0·9939 ,, 0·0006	,,	0·9933
	Zn.	Al.			
8.	0·1038	0·9	0·1079		
9.	0·1012	0·9	0·1051		
10.	0·5001	0·5	0·5094		
11.	0·4998	0·5	0·5058		
12.	—	2	0·0004		

(No. 12 was taken from the same ingot as the preceding portions of Al).

2. Solution of Sulphate of Zinc treated with Organic Salts, and a Slight Excess of Acetic Acid.

This method is not applicable in the presence of iron—which reduces its importance considerably. In fact, the iron has a tendency to decompose partially with the zinc, not to the state of metallic iron as we stated in error (*Bull. Soc. Chim.*, vol. xvii., p. 887), but to a state of oxidation or saline combination that we have not been able to determine.

In the absence of iron this method is good. The instructions given in our previous paper (*loc. cit.*) must be followed, with the exception that the electrodes must be made according to our new system, with the cathode of platinum gauze, and the current should be 1 ampère. Care must be taken to cover the cathode with copper before depositing the zinc, to prevent the latter adhering to the platinum.

The separation of zinc and aluminium is difficult to effect by this method, on account of the precipitation of alumina during the electrolysis, which precipitation may carry down zinc. This difficulty is also met with when using the oxalate method.

Experimental Results.

The zinc used in these experiments contained 0·18 per cent of lead.

	Amount taken. Grm.	Deposit.
1. Zn	0·5000	0·5031
2. Zn	0·5000	0·5039
3. Zn	0·3000	0·3027

—*Bull. Soc. Chim.*, Series 3, vol. xxix., No. 7.

Change of Address.—Mr. J. L. C. Eckelt informs us that he has removed his offices from 83, Prinzen-Allee to 19, Chaussee-Strasse, Berlin.

* Actually, the iron is very slightly soluble; if we refer to the experimental results, we see that with the zinc there are deposited quantities of iron varying from 0·0016 to 0·0021 grm. when there is 15 c.c. of soda in excess, and from 0·0004 to 0·0016 grm. with an excess of 80 c.c. of soda. Thus a large excess of soda is rather favourable; this has also been shown by the analysis of the mother-liquors, from which the zinc was removed by electrolysis.

PROCEEDINGS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Centenary of the Announcement of the Atomic Theory by John Dalton.

"*The Atomic Theory.*"* By F. W. Clarke.

One hundred years ago, John Dalton gave before the Manchester Literary and Philosophical Society the first hint of his atomic theory.

It was only a preliminary notice; a mere note appended to a Memoir on another subject, and it attracted little attention. In 1808, however, he published his "New System of Chemical Philosophy," and since then the history of chemistry has been the history of the atomic theory. To celebrate Dalton's achievement, and to trace its influence upon science, is the purpose of this lecture.

The earliest recorded attempts to form an atomic theory were made by the Greek philosophers. Leucippus came first, to be soon followed by Democritus and Epicurus. Then came the Roman, Lucretius, who gave the doctrine the most complete statement of all. These attempts were all qualitative, and had little effect upon the development of science. They were mere speculations, of no direct utility to mankind; and they they gave rise to interminable controversies of a metaphysical character.

Early in the seventeenth century, Gassendi revived the atomic philosophy of Epicurus, and he was soon followed by Boyle, by Newton, and by many others. These men were the real precursors of Dalton, to whom their teachings were well known. In chemistry, the first atomistic treatise seems to have been written by Swedenborg, in 1721; something was done by Bryan Higgins, of London, in 1775, and a better statement was published by William Huggins, of Dublin, in 1789. None of these attempts were effective, however, and none of them lead to discoveries. The time was not ripe, the data were too few; but the right moment came to Dalton, who knew how to use it well. Dalton established on a firm basis the law of definite proportions, and then the law of multiple proportions, and finally he discovered that to every chemical element a definite combining number, the relative weight of its atom, could be assigned. This new atomic theory, which figured chemical union as a jutaposition of atoms and gave to every atom a definite weight, put chemistry for the first time upon an absolutely general quantitative basis. Dalton thus created a working tool of extraordinary power and usefulness; something which none of his forerunners had been able to do. In the growth of chemistry, since his day, the guiding clue has been the atomic theory.

The development of the new doctrine followed two distinct lines; one chemical, the other physical. On the chemical side, Berzelius made many determinations of different atomic weights, invented symbols, and devised the system of chemical formulæ and equations which, somewhat modified, is now everywhere in use. On the physical side, Gay-Lussac connected the new atomic weights with the densities of the gases, and Avogadro, introducing into science the distinction between atoms and molecules, discovered a fundamental law. Equal volumes of gases, under equal conditions, contain equal numbers of molecules. In 1819, Dulong and Petit discovered the law connecting the atomic weights of the elements with their specific heats, and this law, with Avogadro's, ultimately gave the atomic theory its present form.

From 1820 until 1850, the growth of chemistry was mainly on the organic side; but every step forward was dependent upon Dalton's theory. The conceptions of compound radicals, the laws of substitution, and the theories of chemical structure were among the great advances mentioned. The discovery of isomerism, of the fact that two radically different compounds may contain the same elements in exactly the same proportions, was especially important. The same atoms were differently arranged, and on that supposition only could the phenomena be explained. Without the atomic theory organic chemistry would be quite unintelligible; a mere dust heap of unrelated facts.

Between 1850 and 1860, it was found, through the labours of several chemists, notably Frankland and Kekulé, that every elementary atom had a definite capacity expressible by number for combining with other atoms. From this conception important consequences followed; some of them industrial, and others more purely scientific. This subject was quite fully discussed by the lecturer, who then passed on to another question, that of relations between the atomic weights of the different elements. Through investigations of this class, Mendeleeff in 1869 discovered the periodic law, and showed that all the properties of the elements were dependent upon the atomic weights. Furthermore, Mendeleeff, finding gaps in his classification, predicted the existence of three unknown metals and foretold their properties. This extraordinary prophecy has since been completely fulfilled, and the three metals gallium, scandium, and germanium are now well known. In short, the properties of all substances are intimately connected with their atomic or molecular weights, so that the set of numbers discovered by Dalton are the fundamental constants of all exact chemistry.

The acceptance of Dalton's atomic theory leads at once to two other problems of great interest. What is the nature of the atom? And is all matter *one* at bottom, or of many kinds? On the latter subject most philosophical chemists are now of the belief that our elements are not ultimate; and the only evidence in favour of their elementary nature is the fact that with our present resonrces we are unable to decompose them. On the other hand, they are connected by so many close relations that something belonging to them in common must underlie them all. Several lines of evidence bearing upon this side of the question were cited, and among them the evidence of the spectroscope as applied to the heavenly bodies. The nebulæ are chemically simple; the hotter stars more complex; the finished planets most complex of all. It is possible, then, that the evolution of planets from nebulæ has been accompanied by an evolution of the elements themselves.

If these considerations are valid, then the Daltonian atoms must be complex bodies. J. J. Thomson, of Cambridge, has recently shown that bodies smaller than atoms can be identified by electrical means; Prof. Rutherford, studying the phenomena of radio-activity, has obtained evidence pointing in the same direction; and it begins to seem probable that radio-activity is a phenomenon of atomic decay. An actual breaking down of the heavier atoms seems to be almost within our reach. But all investigations of this sort are so new that we must hold our opinions concerning them open to revision.

As to the nature of the atom, the lecturer referred to Lord Kelvin's theory that they may be vortex rings in the ether; to Prof. Larmor's conclusion that they are centres of strain in the ether; and to Prof. Osborne Reynolds's recent remarkable theory which derives them from irregularities in a universal granular medium. His own opinion coincides with J. J. Thomson's conclusion, that the atoms are clusters of small corpuscles, for this best harmonises with chemical data. The ultimate corpuscles are all equal to one another; that is, they are all alike.

In conclusion, Prof. Clarke reiterated his statement as to the fundamental importance of the atomic weights, and urged the importance of their more exact measurement. To this end he advocated co-operative research between all workers in this field, and the endowment of laboratories. Who will establish the Dalton laboratory for pure research?

* The Wilde Lecture.

NOTICES OF BOOKS.

Quantitative Chemical Analysis by Electrolysis. By ALEXANDER CLASSEN. Authorised translation. Fourth English from the Fourth German Edition, Revised and Enlarged, by BERTRAM B. BOLTWOOD. New York: John Wiley and Sons. London: Chapman and Hall, Ltd. 1903. Pp. vii.—315. 8vo. Illustrated.

PROF. CLASSEN'S standard work here named is so well known, both in Germany and in English-speaking lands, that mere announcement of a fourth edition will interest the many already using it; this new edition contains many additional electro-analytical processes which have been invented since 1897. In preparing the English translation Dr. Boltwood had the privilege of using Prof. Classen's new work, "Select Methods in Analytical Chemistry," published in 1902, as well as of Hastings and Beach's "Text Book of General Physics."

Those familiar with the former editions will remember the clear descriptions of apparatus and methods in the first eighteen chapters and the numerous references to literature in the special part. The author shows his appreciation of bibliography so strongly that it seems unfortunate that the brief Historical introduction contains no reference to original papers, even when dates are given.

It must be gratifying to Americans to notice how frequently methods devised by Prof. Edgar F. Smith, of the University of Pennsylvania, are cited with approbation.

A few full-page illustrations, from photographs, assist in elucidating the subject.

Two indexes, one to Authors and one of subjects, both alphabetically arranged but separately printed close this valued work, but why separate into two divisions an alphabetical index? H.C.B.

The Principles of Physical Chemistry. ("Traité de Chemie Physique; Les Principes"). By JEAN PERRIN. Paris: Gautier-Villars. 1903. Pp. 299.

THE principles, of which the discussion and examination form a natural introduction to the different physical sciences, are the subject of this volume. The philosophical value of these principles lies in the fact that every one of them is suggested by the simple comparison of known facts, without the necessity of representing the world otherwise than it appears to us. In opposition to this inductive method, there has developed another method which consists in imagining for matter, *à priori*, a structure of which the direct perception escapes our limited senses, and by which we are enabled to foresee the properties of matter by deductive means.

It cannot be denied that by the latter method much brilliant work has been accomplished and many facts foretold. In this volume the author deals entirely with the application of inductive methods, though he protests against a judgment which would condemn molecular theories *en bloc*, instead of being satisfied with pointing out the limits beyond which they cannot pass.

The book is divided into nine chapters, and these are each sub-divided into four or five sections. The first chapter is on the "Idea of Force," static, dynamic, &c. Chapter II., on "The Factors of Action," deals with tensions and pressure, electromotive force, temperature, radiation, and chemical action; then come two chapters on energy and work. Chapter V. is on the "Principle of Evolution," and Chapter VI. on the "Characteristics of Stable Equilibrium." The remaining chapters become a little more chemical in their characteristics, though everything is treated from a mathematical point of view; in fact, the whole volume is mathematical and theoretical in character, and can by no means be glanced through in a casual manner.

It is provided with a comprehensive table of contents, but, as is so often the case with foreign works, there is no index.

The General Laws of the Action of the Diastases. ("Loi Générales de l'Action des Diastases"). By VICTOR HENRI. Paris: A. Hermann. 1903. Pp. 129.

AMONG the phenomena which take place in the living organism, the processes of nutrition, of absorption, of secretion, and of support of the cells of the organism, in fact, the whole of the metalbolism of the living body, may be considered as being almost entirely reducible to diastasic action. As experimental researches increase, the number of actions, considered previously as being intimately connected with the vitality of certain cells, diminish. The subject of the present volume is the examination of the laws governing diastasic action, and the plan adopted is to examine the action of diastases by means of the methods and results obtained by means of physical chemistry; these methods are referred to briefly in the introduction.

Only three diastases have been considered in this volume—invertine, emulsine, and amylase. These diastases have the advantage of enabling a quantitative examination of their action to be made with greater ease than with most other diastases. Still, only the first portion of the experimental examination of diastasic action is contained in the present volume; for instance, the effect of temperature and the different conditions of the medium used have not been dealt with. But in spite of this, the author has put forward a general theory of diastasic action, which brings these effects completely within the range of general chemical laws. He proposes to classify catalytic action under the five following headings:—1. Pure catalysis by simple presence. 2. Auto-catalysis. 3. Formation of intermediate compounds produced very rapidly; these compounds may be complete or incomplete. 4. Intermediate compounds produced slowly. 5. Action of a catalysing agent on a series of successive reactions.

Photographic References for 1903. ("Aide-mémoire de Photographie pour 1903"). Published under the Auspices of the Photographic Society of Toulouse. By C. FABRE. Twenty-eighth Year. Third Series, Vol. VIII. Paris: Gautier-Villars. 1903. Pp. 340.

THIS annual, which is the oldest French publication of its kind, has just been published. The beginner as well as the practised operator will find many practical hints which will be of use to them during the coming season. As in previous editions, the author does not limit himself to a bare statement of formulæ, &c., but he also gives useful advice as to manipulation so as to obtain good negatives and satisfactory pictures.

Die Grundzüge der Chemischen Didaktik. ("The Outlines of Chemical Didactics"). By Dr. A. WOLFRUM. Leipzig: Wilhelm Engelmann. 1903.

THIS book has been written for the purpose of advising students of chemistry, or those who are about to take up the study, concerning their subject, and the best and most rational way to make the most of the time they have to devote to it. The whole spirit of the book tends to set a high ideal before the student, and to stimulate his mental activity. A complete plan of study is given, based upon practical experience, with hints on special requirements and details of examinations, as well as suggestions for the most profitable manner in which to set about original research, all of which throw incidentally an interesting side light on German aims and methods. The author also deals with laboratory instruction in its various aspects, the objects and usefulness of qualitative and

quantitative analysis and technical processes, with a short essay on the influence of the teacher on the special method of study adopted. No one will be found to deny that at any rate until very recently there has been urgent need of reform in methods of teaching chemistry, and this thoughtful study of a rational system will undoubtedly be found to contain many hints and valuable suggestions, by which both teachers and students may benefit.

Elektro-metallurgie. Die Gewinnung der Metalle unter Vermittlung des Elektrischen Stromes. Erste Abtheilung. ("Electro-metallurgy. The Preparation of Metals by means of the Electric Current." Part I.) By Dr. W. Borchers. Leipzig: S. Hirzel. 1902.

This is the third edition of Dr. Borchers' book, and has been considerably enlarged, and to a great extent re-written. Owing to the need for keeping pace with the rapid development of the subject, we should have thought that it would have been better to omit many of the descriptions of earlier processes in favour of an increased attention to more recent methods. This volume is the first part of the work, and includes the preparation by the help of the electric current of the metals of the alkalis and alkali earths, and also copper and nickel. Many of the processes described are rapidly becoming obsolete, being superseded by cheaper or more expeditious methods; but, on the other hand, in many respects the information is most concisely and well stated, as, for example, in the section on the preparation of cerium. The book is fully illustrated, and will be found specially suitable for use as a text-book of moderate difficulty.

Chemisches Praktikum. II. Teil. *Präparative und Fabrikatorische Ubungen.* ("Practical Chemistry. Part II. Preparations and Manufacturing Processes"). *Atlas zum II. Teil.* ("Atlas" to Part II.). By Dr. A. Wolfrum. Leipzig: Wilhelm Engelmann. 1903.

The second part of Dr. Wolfrum's work on practical chemistry deals with manufacturing processes and methods of preparation generally; the illustrations are collected in a separately bound Atlas, arranged specially for use with the text-book, a plan which seems to have a good deal to recommend it. The first section of the book describes the treatment of substances by mechanical means, preparatory to their subjection to chemical processes, with the various methods of attaining the necessary conditions of reaction by mixing, shaking, distilling, &c. All these methods are fully illustrated in the atlas. The second section comprises a collection of methods of preparation of many inorganic and organic compounds, the latter of which will be found specially useful by teachers; by judicious selection a very instructive course of practical work in organic chemistry could be adapted from it. This section appears to be thoroughly systematic and accurate, and the various examples are always well chosen, sufficient details being given to enable the student to perform most of the operations without further instruction or assistance. The rest of the book is written from a more purely technical point of view, and summarises the facts influencing the choice of apparatus and machinery, their output and cost of maintenance, with many valuable hints to the managers of factories and works. The methods of preparation of various chemical products are described, rather too shortly, however, for practical purposes, owing to the comparatively small space necessarily allotted to this branch of the subject.

The Atlas contains some 700 illustrations of pieces of apparatus and machinery, and eleven tables to show the arrangement of more complicated plant; this Atlas will be found useful both for technologists and for laboratory purposes. The illustrations have been carefully prepared, except in a few cases, as, for example, that of the Soxhlet's apparatus on page 41, which would probably not be clear to those who had not previously handled the apparatus in some form.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 17, April 27, 1903.

Catalytic Decomposition of Alcohols by Finely-divided Metals. Allylic and Benzylic Alcohols, Secondary and Tertiary Alcohols.—Paul Sabatier and J. B. Senderens.—In recent papers the authors showed that copper prepared by reduction of its oxide caused a regular decomposition of formenic primary alcohols into aldehyde and hydrogen at a temperature below 300°. At higher temperatures, or in the presence of reduced nickel or platinum sponge, instead of aldehyde, the products of its decomposition are carbonic oxide and hydrocarbons. The authors now extend their research, using allylic and benzylic alcohols. In the case of secondary alcohols, a regular decomposition takes place into acetones and hydrogen, the stability of the acetones being greater than that of the aldehydes. Tertiary alcohols, under similar conditions, are transformed into water and ethylenic carbides.

Cementation of Iron.—Georges Charpy.—The cementation of iron is not only caused by the solubility of carbon in iron; it can be produced either under peculiar conditions, especially at low temperatures, by the transformation of iron into iron carbide, which is a meta-stable body, or under normal conditions by the indefinite transformation of carbon into graphite through the medium of a limited quantity of iron.

Reduction of certain Metallic Halogen Compounds by means of Hydrogen. Influence of Pressure.—A. Jouniaux.—Glass tubes containing a metallic chloride, bromide, or iodide are filled with pure dry hydrogen under reduced pressure and then sealed. The absolute temperature of the gas is noted. The system is then raised to a high temperature, quickly cooled, and a volumetric analysis of the gaseous mixture obtained.

Electrolytic Reduction of Chlorate of Potash.—D. Tommasi.—During the electrolysis of a solution of potassium chlorate acidulated with sulphuric acid, an oxidation or reduction of the chlorate takes place, according to the nature of the anode. When platinum electrodes are used, perchlorate is formed at the anode without a trace of chloride at the cathode. With a cathode of platinum and an anode of zinc, potassium chloride is produced at the anode only, with no reduction of chlorate at the cathode. The reduction in this case is attributed, not to hydrogen, but to zinc; this latter substance combining with the oxygen of the chlorate to form zinc oxide, and so reducing the chlorate to chloride:—

$$KClO_3+3Zn=KCl+3ZnO.$$

$$3ZnO+3H_2SO_4=3ZnSO_4+3H_2O.$$

If a solution of chlorate containing no sulphuric acid is used, a white precipitate of zinc hydrate is seen at the anode. Potassium perchlorate, when electrolysed in the same manner as the chlorate, undergoes no reduction.

A Reaction by which Symmetric Diphenyl Pyrones are Produced.—R. Fosse.—The author devises a general method of preparation of the diphenyl pyrones. This consists in treating the orthophosphoric ethers of phenols at a high temperature with potassium carbonate. This carbonate reacts equally on the salicylic ethers, and the following rule can be formulated:—At a temperature below their boiling- or decomposition-point, the diphenyl carbonic ethers and the salicylic ethers (salols and salicylates of alcohols), when heated with the alkaline carbonates, undergo a transformation, with evolution of carbon dioxide gas.

Bulletin de la Société Chimique de Paris.
Series 3, Vol. xxvii., No. 23.

Preparation and Properties of Hydride of Potassium.—Henri Moissan.

Preparation and Properties of Hydride of Sodium.—Henri Moissan.

New Synthesis of Formic Acid.—Henri Moissan.

Action of Hydride of Potassium on Iodide of Ethyl and Chloride of Methyl. New Preparations of Ethane and Methane.—Henri Moissan.—The above four papers have been already noticed in these columns.

Action of Hydrochloric Acid on the Sulphates of the Sesquioxides of Aluminium, Chromium, and Iron.—A. Recoura.—Already inserted in full.

Mutual Isomerations of the Acylacetylacetic Ethers.—L. Bouveault and A. Bongert.—The authors have endeavoured to find out whether they could apply MM. Claisen and Haase's method of partially transforming the *o*-acetylacetylacetate of ethyl into its isomer the diacetylacetate, to the substances which have formed the subject of their own researches. For this purpose they prepared the *o*-butyrylacetylacetate of methyl already described by them, and following the method given by the above-mentioned chemists, they obtain 70 per cent of the theoretical amount of pure *o*-butyrylacetylacetate of methyl, showing that the method can be generalised. To transform the *o*-butyrylacetylacetate of methyl into the *c*-acylised derivative, they again followed the general method described by the German chemists with satisfactory results.

Action of Fuming Nitric Acid on the Acylacetylacetates and the Acetylacetates of Methyl and of Ethyl.—MM. Bouveault and A. Bongert.—Brown fuming nitric acid was added, a little at a time, to C-butyrylacetylacetate of ethyl. The action proceeds as in ordinary nitration; the mixture is then poured into water, and this water shaken up with ether, and the ether is washed successively with water, carbonate of soda in excess, and again with water; the ether is then driven off on the water-bath. A mobile liquid remains, which, contrary to expectation, distils *in vacuo* without any decomposition. In this manner a rather thick liquid is obtained, boiling at 170—171° under 23 m.m. It is of a light amber colour, and possesses a peculiar though not very penetrating odour, and causes itching on contact with the skin. It corresponds to the formula $C_4H_5NO_3$. However, its molecular weight, determined by cryoscopy in benzene, shows that its formula ought to be doubled, $C_8H_{10}N_2O_6$. It is not easy to account for the formation of this body by means of an equation, but the authors repeated the experiment with C-butyrylacetylacetate of methyl, and obtained a liquid resembling the previous one but boiling at 151° under 10 m.m. Its composition corresponded to $C_3H_3NO_3$, which, according to cryoscopic observations, must also be doubled, $C_6H_6N_2O_6$. As the original bodies were an ethylic and a methylic ether, differing from each other only by CH_2, and as the two products differ by C_2H_4, it follows that these latter bodies both contain the ether group twice. Therefore the formula of the former must be written $C_2N_2O_2(CO_2C_2H_5)_2 = C_8H_{10}N_2O_6$, and that of the latter $C_2N_2O_2(CO_2CH_3)_2 = C_6H_6N_2O_6$. The mechanism of these two reactions becomes clear, and may be represented by the following equations:—

$$2CH_3—CO—\underset{\displaystyle CO—C_3H_7}{\overset{\displaystyle |}{CH}}—CO_2CH_3 + 2NO_3H =$$
$$= 2C_3H_7—CO_2H + 2CH_3—CO_2H + C_2N_2O_2(CO_2CH_3)_2,$$

and—

$$2CH_3—CO—\underset{\displaystyle CO—C_3H_7}{\overset{\displaystyle |}{CH}}—CO_2C_2H_5 + 2NO_3H =$$
$$= 2C_3H_7—CO_2H + 2CH_3—CO_2H + C_2N_2O_2(CO_2C_2H_5)_2.$$

Examination of the Product of the Nitration of Acetylacetic Ether.—J. Bouveault and A. Bongert.—Already noticed.

Preparation of Tetrachlorophenol.—Et. Barral and E. Grosfillex.—Contrary to the expectations of several chemists, the authors have succeeded in transforming synthetic phenol into tetrachlorophenol by means of a current of chlorine without addition. They effected this in four different manners:—(1) In the presence of chloride of antimony; (2) in the presence of iodine; (3) in the presence of anhydrous perchloride of iron; and (4) by direct chlorination. The purification of tetrachlorophenol is a long and difficult operation; mediocre results were obtained by distilling the product with water, and bad results by distilling *in vacuo*. The use of different solvents, such as benzene, alcohol, or chloroform, did not give any results, both the product itself and the impurities accompanying it being too soluble. The best method is to treat it with petroleum ether, which removes 10 or 15 per cent of the tetrachlorophenol as well as black and red oily impurities, and then dissolve the remainder in a 5 per cent solution of caustic soda; binoxide of sodium is then added, about 10 per cent of the weight of the tetrachlorophenol, and after twelve hours the liquid becomes bright yellow in colour. It is filtered and hydrochloric acid added, drop by drop; filter again, then add an excess of hydrochloric acid to precipitate the whole of the tetrachlorophenol; the latter is dried *in vacuo* over H_2SO_4, and crystallised in petroleum ether, which gives long, white needles, fusible at 67—68°. The return of tetrachlorophenol varies from 75 to 85 per cent.

Acetamido-*p*-benzoyl-β-naphthol and Benzoylamido-*p*-benzoyl-β-naphthol.—F. Reverdin and P. Crépieux.—The chloride of *p*-nitrobenzoyl was condensed with β-naphthol for about a quarter of an hour while heating. The product of the reaction was cooled, filtered, and washed with soda-lye, diluted until it did not dissolve the β-naphthol; it was then purified by crystallisation in acetic acid. The *p*-nitrobenzoyl-β-naphthol thus obtained is in the form of yellow needles, slightly soluble in alcohol, fairly soluble in acetone and benzene; it crystallises well in ligroïn, and fuses at 160°. The acetamido-*p*-benzoyl-β-naphthol is obtained by heating the base to boiling with acetic anhydride in the presence of acetate of soda; to prepare the benzoyl amido-*p*-benzoyl-β naphthol the base is dissolved in the necessary quantity of alcohol, then heated to boiling, and an excess of chloride of benzoyl added. The benzoylised derivative is deposited in the hot liquid, and the product of the reaction takes the form of a white crystalline mass; it is boiled again for a few moments, and filtered by means of the pump. It crystallises in benzene, in which it is slightly soluble, in white needles, fusible at 210°.

MISCELLANEOUS.

The Acid Nature of Acetylene.—Jean Billitzer.—The author has examined the solubility of acetylene in water and in variously concentrated solutions of KOH, NaOH, $Ba(OH)_2$, $Ca(OH)_2$, NH_4OH, H_2SO_4, $CH_3.CO_2H$, and Na_2SO_4. With the exception of baryta and ammonia, all these bodies diminish the solubility of acetylene. We see by this that the influence exercised on the solubility of a substance by the addition of electrolytes is not a simple phenomenon; if we wish to show the specific action of the substance in question it is necessary to compare it, from this point of view, with another body which behaves in the same manner with various electrolytes. If we examine acetylene and ethylene simultaneously, as they fulfil this condition, the comparison of their curves of solubility shows that acetylene is an acid, though a weak one, capable of giving rise to the anions $C{\equiv}CH'$ and $C{\equiv}C''$.—*Zeit. Physik. Ch.*, vol. xl., p. 535.

Contribution to Our Knowledge of Cæsium Compounds.—C. Chabrié.—The cæsium used in these experiments was extracted from American pollux, which contains about 13 per cent of Cs_2O; the mineral is attacked with hydrofluoric acid in a tall, narrow platinum crucible; the solution is freed from the heavy metals, then treated with carbonate of ammonium, and evaporated to dryness; the residue is taken up with water, and the filtered solution is evaporated again to dryness; the new residue is finally treated with boiling alcohol, which dissolves the carbonate of cæsium. The author has prepared the following salts:—Bromide of cæsium, CsBr, by the double decomposition of $BaBr_2$ and SO_4Cs_2, in isotropic crystals. The iodide, CsI, in cubical crystals. The fluoride, CsFl, by the decomposition of the fluorhydrate in an atmosphere of hydrofluoric acid in cubical crystals; the hydrofluorate, CsFl,HFl, obtained from CO_3Cs_2 and HFl, forms exceedingly hygroscopic crystals. The neutral chromate, CrO_4Cs_2, from CrO_4Ag_2 and CsCl, gives long yellow needles. The bichromate, $Cr_2O_7Cs_2$, gives orange-red crystals. The bisulphite, SO_3CsH, is formed by the saturation of CO_3Cs_2 dissolved in alcohol at 99°, by means of SO_2; it forms white crystals, very soluble in water, slightly soluble in alcohol. The sulphite, SO_3Cs_2, formed from the preceding salt and CO_3Cs_2 in alcoholic solution; if the preparation of the sulphite and the bisulphite of cæsium is effected in water, these salts are obtained mixed with a certain quantity of sulphate. Hyposulphite, $S_2O_3Cs_2$, in small needles very soluble in water. Hyposulphate, $S_2O_6Cs_2$, in hexagonal plates belonging to the rhombohedric system. Metavanadate, VaO_3Cs, from Va_2O_5 and CO_3Cs_2.—*Ann. Chim. Phys.*, Series 7, vol. xxvi., June, 1902.

The Decomposition of Mixed Hydrated Crystals.—R. Hollmann.—When two salts ($MnSO_4$ and $CuSO_4$, for example) possess two kinds of isomorphous hydrates, and, consequently, are able to form two kinds of mixed hydrated crystals ($[MnCu]SO_4\,7H_2O$ and $[MnCu]SO_4,5H_2O$), the curves representing the states of equilibrium between these crystals and their solution may correspond to three distinct types, analogous to those which Bakhuis Roozeboom met with in the case of the anhydrous mixed crystals; it may happen that the points of decomposition (temperature at which the higher hydrates decomposes into the lower hydrate and solution) of the mixed crystals may be situated between those of the two component salts, or even that the curve of decomposition (constituted from the points of decomposition relative to the different compositions of the mixture) may show a maximum; or again, that the same curve may show a minimum. The case of the sulphates of Mn and Cu belongs to the second type, that of the sulphates of Mn and Zn belongs to the first. As for the composition of the mixed crystals of the two hydrates, we may state the rule that the mixed crystals of the higher hydrate differ from those of the lower hydrate by a greater richness in that component of which the addition raises the point of decomposition. The gaps often observed in the series of mixed crystals depend essentially on the temperature, so that, by a suitable choice of the isotherm to be described, we are able to obtain complete series of mixed crystals of one or the other hydrate.—*Zeit. Physik. Ch.*, vol. xl., p. 561.

MEETINGS FOR THE WEEK.

TUESDAY, June 2nd.—Royal Institution, 5. "The Work of Ice as a Geological Agent," by Prof. Edmund J. Garwood, M.A.

THURSDAY, 4th.—Royal Institution, 5. "Electric Resonance and Wireless Telegraphy," by Prof. J. A. Fleming, F.R.S., &c.

— Chemical, 8. "Imino-ethers corresponding to Ortho-substituted Benzenoid Amines," by G. D. Lander and F. T. Jewson. "Formation of an Anhydride of Camphoryloxime," "The Mutarotation of Glucose as Influenced by Acids, Bases, and Salts," and "The Solubility of Dynamic Isomerides," by T. M. Lowry. "Isomeric Partially Racemic Salts containing Quinquevalent Nitrogen—Part X., The Four Isomeric Hydrindamine *d*-Chlorocamphorsulphonates, $NR_1R_2H_3$," and "Isomeric Compounds of the Type $NR_1R_2H_2$," by F. S. Kipping. "The Hydrolysis of Ethyl Mandelate by the Fat-splitting Enzyme Lipase," by H. D. Dakin.

FRIDAY, 5th.—Royal Institution, 9. "The New Star in Gemini," by Prof. H. H. Turner, D.Sc., F.R.S.

SATURDAY, 6th.—Royal Institution, 3. "The 'De Magnete' and its Author," by Prof. S. P. Thompson, F.R.S.

Re Pirie *v.* The Company and Others.—The Electro-Chemical Co. (1900), Ltd., 1901, E. 85.—By orders of Mr. Justice Farwell.

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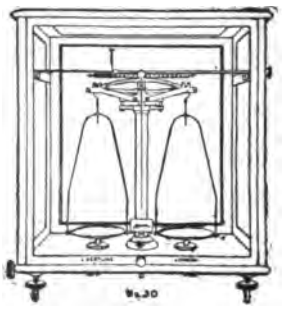

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THE CHEMICAL NEWS

VOL. LXXXVII., No. 2271.

THE USE OF THE ZINC REDUCTOR IN THE ESTIMATION OF VANADIC ACID.*

By F. A. GOOCH and R. D. GILBERT.

THE reduction of vanadic acid to the condition of vanadium tetroxide preparatory to estimating it by titration with potassium permanganate is generally accomplished by the use of sulphurous acid or hydrogen sulphide. The more convenient method of treatment by zinc and free acid is not directly applicable on account of the irregular reduction of vanadic acid under the conditions to a stage approximating that of the dioxide, as was first shown by Czudnowicz (*Ann. Phys.*, 1863, cxx., 39). The work herein described is the result of an attempt to find a reliable method for bringing the product of reduction of vanadic acid by zinc and acid definitely to the condition of the tetroxide, in order that the reductor so useful in the preparation of salts of iron for titration by potassium permanganate may be made similarly applicable in the estimation of vanadic acid and its salts.

A very convenient form of reductor (described in Blair's "Chemical Analysis of Iron," edition of 1902, p 93) was made as follows—The contracted end of a piece of glass tubing, 2 c.m. in inside diameter and 50 c.m. long, was sealed to stop-cock prolonged in a smaller tube, 0·5 c.m. in inside diameter, to a length of 24 c.m. At the point of contraction in the larger tube was placed a piece of platinum gauze, next to this a mat of fine glass-wool 2 c.m. in thickness, and upon the last a column 40 c.m. long of amalgamated zinc of a size to pass a sieve of eight meshes to the centimetre. The smaller tube passed through a rubber stopper fitted to a vacuum flask, and the last was connected through a pressure regulator with the vacuum pump. In using this apparatus the pump was started, the regulator set to give a pressure in the flask less than the outside pressure by an amount equal to 20 c.m. of water; the reducing column of zinc was warmed by passing through it hot distilled water followed by 100 c.m.³ of hot 1 per cent sulphuric acid, and then the solution of the salt of vanadic acid to be reduced was gradually drawn through the zinc in small portions, alternating with portions of the 1 per cent sulphuric acid amounting to 100 c.m.³. Finally, the column was washed down with 100 c.m.³ more of the dilute sulphuric acid and about 250 c.m.³ of hot distilled water. Throughout the entire series of operations care was taken to keep the zinc covered with liquid and so out of contact with the air.

The lavender solution collected in the flask contains vanadium dioxide, which when exposed to the action of a current of air takes, as Roscoe has shown (*Ann. Pharm*, Suppl, 1868, vi., 98), the blue colour of the tetroxide. The first attempts, therefore, to bring about definiteness of condition were made along the lines of Roscoe's observation. The solutions obtained in the receiving flask were treated by air at various temperatures and for various lengths of time, and then, after heating to 80°, were titrated with nearly N/20 potassium permanganate standardised by reference to N/20 arsenious oxide.

This most exact method of standardising the permanganate was carried out by adding a convenient volume (43 c.m.³) of the permanganate to a solution of potassium iodide (3 grms.) acidulated with sulphuric acid (3 c.m.³ of the 1 : 1 acid) contained in a glass-stoppered flask fitted with a funnel tube and trapped, introducing through the funnel tube an excess of a standard solution of N/20 arsenious oxide, neutralising with acid potassium carbonate, and titrating in presence of starch with iodine also standardised against the arsenious oxide.

In blank experiments made from time to time with the reductor it was found that the reading colour developed in the acid solution only after the addition of 0·2 c.m.³ of the standard permanganate, and this correction, due to traces of iron in the zinc and the considerable volume of the solution, was applied in the experiments in which the vanadium salt was treated. In our experiments ammonium vanadate was the salt of vanadic acid employed, and the sample with which we worked contained 76·66 per cent of V_2O_5, as determined according to the iodometric method of Holverscheit (Inaug. Diss. Berlin, 1890, p. 49.

The results of some attempts under most favorable conditions to effect the oxidation of the reduced trioxide to the condition of the tetroxide by the action on air are given in Table I. These show plainly that, although the oxidation by air appears to proceed rapidly at the outset, the complete conversion of the lower oxides to the tetroxide by such action takes place with too great slowness and uncertainty to form the basis of a reliable and rapid quantitative method.

TABLE I.

Time of treatment by air. Minutes.	Temperature.	V_2O_5 taken. Grm.	V_2O_5 found by titration with $KMnO_4$. Grm.	Error. Grm.
75	56—28°	0·0767	0·0778	+0·0011
75	60—29	0·0767	0·0805	+0·0038
75	48—29	0·0767	0·0829	+0·0062
75	*100°	0·0767	0·0772	+0·0005
75	*100	0·0767	0·0769	+0·0002

* Brought twice to the boiling-point during this interval.

The action of the molecular oxygen of the air is obviously insufficient to bring about the complete oxidation of the lower vanadium oxides in acid solution to the condition of the tetroxide within a reasonable time, and ordinary oxidisers carry the action too far, oxidising the tetroxide as well as the lower oxides. We have found, however, that silver oxide and silver salts will supply oxygen in a condition of activity sufficient to affect the lower oxides easily while leaving the tetroxide intact. Silver sulphate appears to be the most convenient form in which to use the silver compound.

In making our experiments with silver sulphate the solution of the vanadic acid was treated in the reductor in the manner described, except that the receiving flask was charged at the outset with a saturated solution of silver sulphate—100 c.m.³ in each of the first six experiments, 300 c.m.³ in the last two. The contents of the flask were boiled and then filtered upon asbestos in a perforated crucible. The solution, now about 700 c.m.³ in volume, was heated again to the boiling-point and titrated with N/20 potassium permanganate. When the reduced solution issuing from the reductor meets the silver sulphate a muddy deposition of finely-divided silver begins; but upon boiling the mixture the metallic silver gathers into a single spongy mass and leaves the solution so clear that were it not that spongy silver is easily acted upon by the permanganate the titration might be made without previous filtration (Giles, CHEMICAL NEWS, 1867, xv., 204; Otto van der Pfordten, *Ber.*, xx., 3375; Friedheim, *Ber.*, xx., 2554).

TABLE II.

V_2O_5 taken. Grm.	$KMnO_4$ required, nearly N/20. C.m.³.	V_2O_5 found. Grm.	Error. Grm.
0·0767	17·	0·0770	+0·0003
0·0767	17·04	0·0771	+0·0004
0·0767	17·05	0·0772	+0·0005
0·0767	16·96	0·0768	+0·0001
0·0767	16·98	0·0769	+0·0002
0·0767	17·	0·0770	+0·0003
0·1918	42·9	0·1942	+0·0024
0·1918	42·7	0·1933	+0·0015

* Contributions from the Kent Chemical Laboratory of Yale University. From the *American Journal of Science*, xv., p. 389.

The results of these experiments are given in the accompanying table. For the smaller amounts of vanadium the determinations are accordant and exact. The wider variations in the last two experiments are probably due to the difficulty of catching the pink end-reaction in presence of the reddish yellow colour which appears as the vanadic acid is formed in considerable amount. This is a difficulty inherent in the permanganate process of titration when large amounts of vanadic acid are involved.

METHODS FOR THE ESTIMATION OF GUTTA-PERCHA.

By Dr. ED. MARKWALD and FRITZ FRANK.

The information met with in chemical literature on the properties and estimation of gutta-percha is fairly considerable, but it is rather indefinite and but slightly concordant.

Thus, according to Payen (*Comptes Rendus*, vol. xxxv., p. 109), ether dissolves only a part of the gutta, while Arppl (*Dingl. Polytech. J.*, vol. cxxi., p 442) observed complete solution when the ether is anhydrous and free from alcohol; alcoholic ether leaves portions undissolved. More recently Obach ("La Gutta-percha," 1899, p. 25) gives gutta-percha, or at least the hydrocarbon portion of the natural product, which is the true gutta-percha, as entirely soluble in ether which would only dissolve the resins albane and fluavile.

The technical works are full of contradictions of this kind.

As methods of estimation, properly so called, we would mention that of Henriquès, who dissolves the resins by extraction with ether, petroleum ether, or acetone, and weighs them directly by evaporating the solvent, or indirectly by the loss of weight of the gutta extracted. Then he takes up the latter with sulphide of carbon or chloroform, filters, distils, and dries *in vacuo*.

Obach's method hardly differs from the preceding one: The material, dried and suitably pulverised, is extracted with ether or ligroin. The resins are determined by the loss of weight of the substance dried until the weight is constant, or by direct weighing after the evaporation of the solvent. The gutta in the residue is dissolved with sulphide of carbon or chloroform, the organic detritus and other impurities are separated by filtration; the solution is then concentrated and the gutta precipitated with alcohol.

H. Borntraeger (*Gummi Zeitung*, 1899, p. 631) proposed another method, in all respects similar to the preceding ones.

Having had occasion, during the past few months, to make a large number of analyses of gutta-percha for which a close concordance of results was necessary, and having observed that we obtained, on the contrary, considerable differences between one estimation and another when using the known methods, we sought about for a more exact means of effecting the determinations. It is the result of this research that we are about to describe.

We observed that the methods of Henriquès and Obach erred especially in the extraction of the resins. If we employ maceration in the cold the resins are always incompletely dissolved. If we employ heat, with acetone, in a Soxhlet apparatus, the filaments of gutta, no matter how finely they are divided, soon agglomerate into a mass that the solvent is unable to penetrate; with petroleum ether, or ether, the extraction is not limited to the resins, but a variable portion of the gutta also is attacked by the solvent.

The second operation, solution of the residue from the previous extraction by sulphide of carbon or chloroform, filtration and precipitation by alcohol, is not easy to perform. If we use sulphide of carbon, the extreme volatility of the solvent complicates the operation. With chloroform a considerable weight of the solvent is required to obtain a solution sufficiently fluid to filter easily.

After having determined the proportion of water in the sample, by the known method, we proceeded as follows:—

A. *Solution in Chloroform. Precipitation with Acetone.*

About 2 grms. of dried gutta are dissolved in 15 cubic centimetres of chloroform, and the clarified solution is poured, very gradually and with constant stirring, into 75 cubic centimetres of acetone in a tared Erlenmeyer flask. The gutta separates in the form of a voluminous porous precipitate, which can be collected and washed with ease. The resins and fats remain dissolved, the mechanical impurities remain in suspension. After decantation into another tared flask, the gutta is washed with acetone and the liquors all added together.

The gutta is dried at 100° and weighed; the resins are treated in the same manner. If we wish to weigh the insoluble impurities, in the estimation of a raw gutta for example, the filtration must be done through a tared filter paper.

It will be observed that the acetone must not be poured into the chloroform solution, as in such a case the gutta would separate in a compact mass, retaining the resins which could not be entirely removed by the subsequent washings. The resulting errors amount to 5 per cent.

Narrow-necked flasks can be used advantageously for precipitating the gutta; they allow the cake of gutta to be separated more easily and more exactly from the washings by decantation. However, if a morsel of gutta escapes it is taken up, on the filter, by means of warm toluene, after the washing is completed; the toluenic solution is more easy to filter than the chloroformic one. This solution is added to the principal mass of gutta, before evaporation. By this method we can do several complete estimations in one day.

B. *Solution in Chloroform. Precipitation with Alcohol.*

Proceed as in A. The resinous fraction will always be found several per cents too low. We have observed that this is due to the fact that a part of the resins of the gutta is not soluble in cold alcohol, as has already been stated by Payen. By heating, better results are obtained; but the operation is longer and not so convenient

C. *Solution in Chloroform. Precipitation by Ether.*

Two grms. of dried gutta are dissolved in about 10 c.c. of chloroform. This quantity suffices in the present case, as we add the ether to the chloroformic solution, and not inversely as in case A. The first portions of the ether make the solution more liquid, before precipitation takes place. Then we add gradually 100 c.c. of ether. At first the liquor remains limpid; then, after about an hour, the gutta commences to separate out in a voluminous white mass, which completely fills the flask. The precipitation is complete in about twenty-four hours. Filter into a tared matrass, and wash on the filter; the contents of the filter are stirred with a thick stirrer each time until no more liquor runs through, before adding a fresh portion of the washing ether.

The united liquors are evaporated, and the residue of resins is dried at 100° and weighed.

The mass of gutta, contracting by desiccation, takes a normal appearance and can be separated quantitatively from the filter, or weighed in the latter, if it has been tared previously.

If we are operating on a raw gutta in which we have to estimate the insoluble impurities, we take up the cake of gutta with warm toluene and pass through the tared filter, &c.

The quantity of ether indicated for the precipitation cannot be diminished without inconvenience; the separation of the gutta would be incomplete and would take place very slowly. Thus, with 75 c.c. of ether, instead of

100 c.c., we obtained 3 per cent less. With only 50 c.c. the precipitation only commences after about forty-eight hours, and it is not complete even after six days.

D. *Solution in Petroleum Ether.*

In a small matrass, with a vertical condenser, we heat 1 grm. of the dried substance with 100 c.c. of petroleum ether boiling at 35—50° C. for one hour. At the end of this time the solution is complete, but after cooling the gutta separates gradually in the form of a voluminous white mass, filling the whole liquor.

After twenty-four hours the precipitation may be looked upon as complete; filter and proceed as in C.

The following are a few of many analyses we have done:—

1. *Purified Gutta of good quality.*

Process	A.	B.	C.	D.
Gutta	80·21	85·90	79·23	78·55
Resins (by difference)..	19·79	14·10	20 77	21 45
	100·00	100·00	100 00	100·00

2. *Raw Gutta charged with Resins.*

Process	A.	B.	C.	D.
Gutta	46·41	48·61	45·82	46·10
Resins (by difference)..	53·59	51·39	54·18	53 90
	100·00	100 00	100·00	100 00

We see that the methods A, C, and D give fairly concordant results. For reasons of convenience and for economy of solvent we prefer process A, which we recommend to the attention of chemists. We advise drying the precipitates of gutta as much as possible, *in vacuo*, at a temperature not exceeding 50—60°; but if an apparatus of the kind is not available, heating in the oven to 100° will suffice.—*Zeitschrift f. Ang. Chemie*, 1902, p. 1029.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Wednesday, May 20th, 1903.

Prof. W. A. Tilden, D.Sc., F.R.S., President, in the Chair.

Mr. Francis Watts was formally admitted a Fellow of the Society.

Certificates were read for the first time in favour of Messrs. Colin Noel Bennett, 95, High Street, Camden Town, N.W.; William Hunter Gandey, Bradley Court, Mitcheldean, Gloucester; John Howard Linday, Fenton Hall, Great Fenton, Stoke-on-Trent; Arthur Moore, 83, Elgin Road, Seven Kings, Essex; Thomas Rhind, M.R.C.S., 69, Gloucester Road, Regent's Park; Charles J. Smith, Sunnydale, Walton New Road, Stockton Heath; Sidney H. Woolhouse, M.A., 2, Durham Road, Lower Edmonton, N.

The Dalton Centenary.

The President stated that, in company with Sir Henry Roscoe and Dr. T. E. Thorpe, Past-Presidents, Professor Frankland, Vice-President, Dr. Scott, Senior Secretary, and Sir William Ramsay, Foreign Secretary, delegates appointed by the Council, he had taken part in the celebration by the Literary and Philosophical Society of Manchester of the centenary of the enunciation of the Atomic Theory by John Dalton, and in the name of the Chemical Society had presented the following Address:—

The Chemical Society
to the
Literary and Philosophical Society of Manchester.
Greeting.

Recognising the Atomic Theory as having been the foundation of scientific chemistry, the Chemical Society desires to be associated with the Literary and Philosophical Society of Manchester in celebrating the centenary of its enunciation by

John Dalton.

The century which has elapsed since the recognition of the great generalisations which led to the establishment of the theory has afforded continuous proof of its importance throughout the whole domain of physical science, and especially of chemistry, every new development of which has served to consolidate its position.

The Chemical Society offers at the same time to the Literary and Philosophical Society, so much older than itself, an expression of hearty congratulations on having been the medium of the first publication of that theory to the world, and having for upwards of a century so honourably assisted in promoting scientific, literary, and philosophical inquiry, more especially in those early days before the time of Dalton, when the physical sciences were still unorganised and waiting for the firm and philosophical basis on which they now rest.

Signed on behalf of the Chemical Society,

William A. Tilden, President.
Horace T. Brown, Treasurer.
Alexander Scott, } Secretaries.
W. Palmer Wynne, }
William Ramsay, Foreign Secretary.

May 7, 1903.

He reminded the Society that John Dalton was born in 1766, and was therefore a young man when, in 1803, he communicated to the Literary and Philosophical Society a paper "On the Absorption of Gases by Water and other Liquids," to which is appended the first table of atomic weights. Dalton states in the preface to his "Chemical Philosophy," that a brief outline of his views and of the results of his experiments "was first publicly given in the ensuing winter in a course of lectures on natural philosophy at the Royal Institution in London." The first volume of the "Natural Philosophy," containing the well-known symbols of the atoms devised by Dalton, is dated 1808.

The President further announced that a bust of Dalton had been modelled with the aid of the Chantrey marble, and various authentic portraits, one of which a daguerreotype, is in the possession of the Society, and that the bust when finished would be offered to the Society, probably before the end of the session, by our Past-President, Dr. Thorpe.

Centenary of the Birth of Liebig.

The President then stated that he had a further agreeable announcement to make.

The bust of Liebig which was placed on the table is a gift which the Society owes to the generosity of our Fellow, Dr. Messel.

It was probably not generally known that this year, and nearly at this time, is the hundredth anniversary of the birth of the famous German chemist. The day of the month is usually stated to be May 12th, and this is the date given in Hofmann's lecture, delivered berore the Society in 1875, and is therefore probably correct. No time has therefore been lost in honouring this important event.

We in England should be among the first to acknowledge the debt which science and the world at large owes to Liebig. Sixty years ago, when at the height of his fame, he visited England, and although it is true that he found but little science in this country, he had many admirers here who assisted in promoting a knowledge of the principles of plant and animal physiology which had been so largely the product of his own researches. With the advance of time has come so much new knowledge that Liebig's teaching in connection with agriculture, physiology, and medicine seems now to be less influential than it was fifty years ago. We cannot, however, forget that his views represented at that time an immense stride in advance of the state of ignorance which previously

prevailed. As chemists, we more especially recognise our indebtedness to Liebig not only as one of the chief founders of modern organic chemistry, but as having given us the system of practical instruction which, in principle, has been adopted in all universities and chemical schools since his time. Whether any of the students who worked under his direction in the laboratory at Giessen still survive is uncertain, but those who went forth as teachers certainly transmitted to succeeding generations something of the spirit which animated all those who came under Liebig's influence.

Of the following papers, those marked * were read:—

*73. "*The Conditions of Decomposition of Ammonium Nitrite.*" By V. H. Veley.

The decomposition of ammonium nitrate into nitrogen and water proceeds according to the general law, log $A/A-x=a\theta$, whether the reaction follows its normal course or is accelerated by the addition of another substance. The decompositon is either impeded or stopped by ammonia liberated in the solution by the addition of a metallic oxide, this effect being likewise produced by aliphatic, benzenoid, and pyridine amines, also by aromatic hydrazines, and to a less degree by oximes; it is temporarily accelerated by amides of the aliphatic series, but other amides are ineffective. Benzoic sulphinide ("saccharin"), the only imide tried, produces a considerable acceleration, but the reaction proceeds according to the general law.

It does not appear that solutions of ammonium nitrite, prepared from silver nitrite and ammonium chloride, become alkaline in the course of the decomposition. Incidentally it was shown that finely-divided barium sulphate, although producing no permanent effect when added to a solution of ammonium nitrite evolving nitrogen, nevertheless temporarily increased the rate of evolution of nitrogen, owing to some alteration in the amount of dissolved gas.

Discussion.

Dr. Divers thought from the results of the investigation by Dr. Haga and himself of the interaction of sulphurous and nitrous acids in presence of bases, that it was free nitrous acid which, by its action on ammonium nitrite or ammonia, gave rise to the production of nitrogen.

Dr. Lapworth said that Dr. Veley's observations recalled the work of Hantzsch and Schümann, who had shown (*Ber.*, 1899, xxxii., 1691) that the velocity with which diazotisation of aromatic amines takes place is accelerated by an excess of acid. This change is not, as usually represented, a decomposition of the nitrite of the base, but is the effect of free nitrous acid on the substituted ammonium salt, or, in other words, the result of the interaction of the substituted ammonium ions with unionised nitrous acid.

Dr. Veley agreed with Dr. Divers that the initial change in the decomposition of ammonium nitrite was the resolution of the salt into its constituent base and acid, as is also the case with ammonium nitrate. The nitrogen or nitrous oxide resulted from a subsequent interaction of the liberated ammonia with the nitrous or nitric acid respectively.

*74. "*Freezing-point Curves for some Binary Mixtures of Organic Substances, chiefly Phenols and Amines.*" By J. C. Philip.

When the initial freezing-points of a series of mixtures of two substances are determined, and these temperatures are plotted against concentration, a freezing-point curve is obtained which, in the simplest case, consists of two branches, starting from the freezing-points of the constituents and cutting each other at a eutectic point. If however, the two substances can unite to form a compound, the two branches are cut by another intermediate curve, which may sometimes have a summit.

Examples of the latter type of curve with an intermediate branch have been found by the author for the system phenol—urea, where the summit occurs with a mixture containing 33 molecular per cent of urea, and for the systems *p*-cresol—aniline, phenol—α-naphthylamine, phenol—*p*-toluidine, α-naphthol—*p*-toluidine, phenol—picric acid, in all of which cases the summit occurs when the compounds are in molecular proportion.

According to Roozeboom's theory, the summit of the intermediate branch is reached with a mixture corresponding in composition with the formula of the compound, and crystals of this compound separate from all mixtures falling within the limits of the intermediate branch. This view has been confirmed in the above cases by analysis of the crystals which separated when solidification began.

In the freezing-point curve for phenol—urea, the intermediate branch is cut abruptly at the summit by another branch ending, apparently, at the freezing-point of urea. Perhaps the most interesting freezing-point curve obtained was that for phenol—*p*-toluidine, inasmuch as the compound formed by these two substances exists in two modifications with an intermediate branch on the freezing-point curve corresponding with each variety. The compound of phenol and α-naphthylamine crystallises so slowly that it was found possible to realise considerable portions of the ordinary branches of the freezing-point curve underneath the intermediate branch and below the eutectic temperatures.

The compounds of *p*-cresol and aniline (plates; *f.* p. 21°), phenol and *p*-toluidine (plates; *f.* p. 29°), α-naphthol and *p*-toluidine (needles; *f.* p. 53·5°), phenol and picric acid (bright yellow needles; *f.* p. 83°) have not been previously described.

Discussion.

Dr. Lowry referred to the melting-point curves for mixtures of water with succinic and phthalic anhydrides recently plotted by van der Stadt (*Zeit. physikal. Chem.*, 1902, xli., 353). In these cases, the "compound" (that is, the acid) is much more stable and less fusible than its components, so that these only separate from the fused product when this consists of almost pure water or pure anhydride; the central portion of the curve thus extends from about 0 up to 96 or 98 molecular per cent of anhydride. Moreover, the extent to which the "compound" dissociates on fusion can be gauged from the form of the central portion of the curve; if there were no dissociation, this would consist of two intersecting lines, but if there is much dissociation the pointed crest becomes replaced by a rounded summit, and in extreme cases may even be reduced to a broad flattened convexity.

Mr. Crompton inquired whether the author had ascertained to what extent his results were in agreement with the Schroeder-Le Chatelier formula.

Dr. Desch referred to the interest which the author's results presented in connection with the study of metallic alloys, and inquired whether, in the cases examined, the descending and ascending branches of the freezing-point curve were represented by straight lines. In the majority of alloys, these branches are more or less curved, indicating the formation of solid solutions, even if only to a limited extent.

Dr. Philip, in reply, said that the freezing-point curve for the system, acid anhydride—water, which had an intermediate summit at a temperature far above the freezing-points of the constituents, resembled those of the systems, mercury—sodium and α-naphthol—picric acid, studied by Kurnakoff and Kuriloff respectively.

He had not attempted to apply the Schroeder-Le Chatelier formula to his results, as the subject had been treated entirely from the experimental point of view.

The branches of the freezing-point curve, starting from the freezing-points of the components, although sometimes very nearly rectilinear, were, in the majority of cases, slightly concave to the concentration axis.

75. "*Isomeric partially Racemic Salts containing Quinquevalent Nitrogen.* Part XI. *Derivatives of* dl-*Methylhydrindamine and* dl-neo-*Methylhydrindamine. Isomeric Salts of the Type* $NR_1R_2H_3$." By G. Tattersall and F. S. Kipping.

The β-methyl-α-hydrindamine, obtained by reducing methylhydrindoxime, has been separated into the two externally compensated bases of which it is composed by the use of *d*-bromocamphorsulphonic acid, which forms with each of the *dl*-bases a partially racemic salt. The externally compensated base, which is present in the larger quantity, is called *methylhydrindamine*, the other being termed neo-*methylhydrindamine*.

Methylhydrindamine bromocamphorsulphonate,—

$$C_{10}H_{13}N,C_{10}H_{14}OBr\cdot SO_3H,H_2O,$$

crystallises from dilute alcohol in hydrated, rhombodial prisms, and, when dehydrated, melts at 160—165°. In dilute aqueous solution, this salt has a specific rotation $[\alpha]_D = +51\cdot5°$, and a molecular rotation $[M]_D = +235\cdot5°$. These values are abnormal, because, since the salt contains *dl*-base, its molecular rotation should be that of the bromocamphorsulphonic acid, namely, $[M]_D = +270°$.

The *benzoyl* derivative of methylhydrindamine melts at 151°; the *hydrochloride*, *sulphate*, and *picrate* are also described.

neo-*Methylhydrindamine bromocamphorsulphonate*,—

$$C_{10}H_{13}N,C_{10}H_{14}OBr\cdot SO_3H.$$

crystallises from alcohol in large, anhydrous, transparent prisms melting at 194°; its specific rotation in dilute aqueous solution is $[\alpha]_D = +58\cdot9°$, whence $[M]_D = +269\cdot5°$. This value is normal on the assumption that the salt is partially racemic, and this was proved to be the case.

The *benzoyl* derivative of *neo*-methylhydrindamine melts at 169°. The *hydrochloride*, *sulphate*, and *picrate* of the neo-base are also described.

dl-Methylhydrindamine bromocamphorsulphonate is not resolved by ordinary fractional crystallisation, but when treated with a mixture of warm alcohol and ethyl acetate a precipitate of the salt of the *l*-base is obtained, the salt of the *d*-base remaining in solution.

l-*Methylhydrindamine bromocamphorsulphonate* separates from water in long, anhydrous needles, the original melting-point of which is 230°; its specific rotation in dilute aqueous solution is $[\alpha]_D = +45\cdot7°$, and molecular rotation $[M]_D = +209\cdot4°$. The free base is lævorotatory in dilute aqueous solution; its *hydrochloride*, which crystallises from water in needles or plates, has $[M_D] = +56°$.

d-*Methylhydrindamine bromocamphorsulphonate* is indistinguishable in appearance from the salt of the *l*-base; it has an original melting-point of 249°; its specific rotation is $[\alpha]_D = +71°$, and molecular rotation $[M]_D = +326°$. The free base is dextrorotatory in aqueous alcoholic solution.

The formation of isomeric partially racemic salts of the same type as those formed from hydrindamine and *d*-bromocamphorsulphonic acid having been expected, and such isomerides not having been found in the original mixture of salts, the question of their existence was solved by decomposing each of the pure partially racemic salts and regenerating each separately from its components. Crystallisation of the products failed to reveal the presence of any isomerides, so that it is concluded that isomeric partially racemic α- and β salts of methylhydrindamine and *neo*-methylhydrindamine do not exist.

Isomeric Salts of the Type $NR_1R_2H_3$.—On fractionally crystallising *l*-methylhydrindamine bromocamphorsulphonate, the melting-point of the first fraction after about twenty crystallisations rose to 236°, thus indicating that the original salt is a mixture. The pure salt (m. p. 236°) was then decomposed and regenerated from the same base and the same acid; fractional crystallisation of this product gave deposits with melting-points gradually falling from 236° to about 224°. The first and last fractions were found to differ also in specific rotation, the first fraction (*al*) having $[\alpha]_D = +47°$, $[M]_D = +216°$, whilst the last gave $[\alpha]_D = +41°$, $[M]_D = +188°$. The existence of isomeric salts derived from *l*-methylhydrindamine and *d*-bromocamphorsulphonic acid is thus proved.

The isomeric salt melting at 236° is called the *al* salt; the second isomeride, which is named the *βl*-salt, could not be obtained in a pure condition.

The *d*-methylhydrindamine bromocamphorsulphonate obtained by the resolution of the partially racemic salt was treated in the same way as the salt of the *l*-base, and regenerated from its component acid and base; the product was fractionally crystallised. The specific rotations in dilute aqueous solution and the melting-points of the first and last fractions were found to be as follows:—

First fraction (*ad*).. ..	$[\alpha]_D = +73°$, $[M]_D = +334°$; m. p. 262°.
Last fraction..	$[\alpha]_D = +67°$, $[M]_D = +307°$; m. p. about 240°.

Here, again, the existence of isomerides, distinguished as the *ad*- and *βd*-salts, is established, but the former only was obtained in a pure condition.

The original *l*- and *d*-components are, therefore, mixtures, and consist of *al*- and *βl*-, and *ad*- and *βd*-salts respectively. If equal quantities of each are mixed before systematic crystallisation, the original partially racemic salt is obtained. If, however, equal weights of the *al*- and *ad*-salts are mixed, a partially racemic salt, different from the original one, is obtained:—

	M. p.	Crystalline form.	$[\alpha]_D$ in water.
Original partially racemic salt . ..	160—165°	Rhomboidal prisms	+51°
Synthetical partially racemic salt . ..	206°	Rectangular prisms	+60°

The original partially racemic salt consists of the four components, namely, *al*-, *βl*-, *ad*-, and *βd*-salts, and corresponds with the partially racemic β-salt obtained from *dl*-hydrindamine and *d*-bromocamphorsulphonic acid.

76. "*The Action of Liquefied Ammonia on Chromic Chloride.*" By W. R. Lang and C. M. Carson.

When liquefied ammonia acts on violet chromic chloride, a salmon-coloured powder is produced, from which water extracts two distinct compounds which are easily crystallisable *in vacuo*, and correspond in composition with the formulæ $Cr_2Cl_6,12NH_3,2H_2O$ and $Cr_2Cl_6,10NH_3$. The former substance is yellow, whilst the latter has the colour of cobalt nitrate. The salmon-coloured powder, when kept at 15°, yields both yellow and red crystals, but if heated to 110° it gives the red substance only. These compounds are completely decomposed at 180°.

77. "*Note on the Action of Methylamine on Chromic Chloride.*" By W. R. Lang and E. H. Jolliffe.

Methylamine acting on violet chromic chloride produces a pink powder very readily soluble in water, from which it can be crystallised with difficulty owing to the rapidity with which chromium hydroxide separates out. The composition of the crystals corresponds with the formula $Cr_2Cl_6,10CH_3\cdot NH_2$. The pink compound, when heated at 100°, yields a substance containing 8 mols. of ammonia; complete decomposition into chromic oxide occurs at 120°.

78. "*Cholesterol.*" (Preliminary note). By R. H. Pickard and J. Yates.

Owing to the recent publication of the *Habilitationschrift* (Freiburg) of A. Windaus, bearing the above title, the authors wish to state that for over two years they have been investigating the constitution of cholesterol obtained from gallstones. The effects of nitric acid, fused potassium hydroxide, potassium chlorate and hydrochloric acid, and alkaline permanganate solution on cholesterol have been studied in turn. The results hitherto obtained show that the cholesterol is composed of a very stable, complex nucleus joined to a normal chain of some nineteen carbon atoms, inasmuch as arachidic acid, $C_{20}H_{40}O_2$, is one of the products of its oxidation. The

hydrocarbons obtained when cholesterol is treated with dehydrating agents and the action of alkalis on the halogen derivatives of cholesterol are also being investigated.

79. "*Hydrogen Cyanide in Fodder-plants.*" By J. C. Brünnich.

After the important discovery, by Messrs. Dunstan and Henry, of a glucoside "Dhurrin" (*Proc. Roy. Soc.*, 1902, lxx., 153) in the young plants of sorghum, which, on decomposition in presence of water, yields hydrogen cyanide, the author, on behalf of the Queensland Department of Agriculture, carried out a series of experiments in order to ascertain at what stages and conditions of growth the fodder-plants belonging to the sorghum family are most dangerous. Two varieties of sorghum, and also a variety of maize, were grown on unmanured and heavily manured plots, and analysed at various stages. The results show that sorghums should never be used as fodder in very young and immature stages of growth.

80. "*Sulphocampholenecarboxylic Acid.*" By A. W. Harvey and A. Lapworth.

When sulphocampholenecarboxylic acid (*Proc.*, 1902, xviii., 142) is oxidised with potassium permanganate, no oxalic acid is formed, and the product consists almost entirely of acids which cannot be removed from a strongly acidified aqueous solution by ether, ethyl acetate, or acetone, and is therefore probably a mixture of sulphonic acids. A minute quantity of a volatile fatty acid, perhaps acetic acid, was detected. When the oxidation product is carefully fused with potassium hydroxide, it yields a mixture of carboxylic acids, the main constituent being identified as $\alpha\alpha$-dimethylglutaric acid.

The *methyl* ester,—

$$CO_2Me\cdot C_9H_{14}Br\cdot SO_2\cdot O$$

(m. p. 192—193°), and the *ethyl* ester,—

$$CO_2Et\cdot C_9H_{14}Br\cdot SO_2\cdot O$$

(m. p. 101—102°), are very easily obtained from the sultonecarboxylic acid (*loc. cit.*) by Fischer's method. The carboxyl group is therefore attached to a hydrogenated carbon atom.

The above observations indicate (1) that in the formation of sulphocampholenecarboxylic acid from α-bromocamphor, scission has occurred between the carboxyl group and the trimethyl*cyclo*pentane nucleus, (2) that the acid does not contain the group $:C:CH\cdot CO_2H$, but probably $:C\cdot CH_2\cdot CO_2H$, (3) that it is most probably related to β- and not to α-campholenic acid in spite of its optical activity, which is perhaps due to the presence of the sulphonic group.

81. "*Optically Active Esters of β-Ketonic and β-Aldehydic Acids.* Part III. *Azo-derivatives of Menthyl Acetoacetate.*" By A. Lapworth.

Menthyl phenylazoacetoacetate,—

$$C_6H_5\cdot N_2\cdot CHAc\cdot CO_2\cdot C_{10}H_{19},$$

from menthyl acetoacetate and phenyldiazonium sulphate in presence of sodium acetate, forms large, transparent crystals melting at 76—77°. In a 1½ per cent solution in benzene, it has initially $[\alpha]_D = -21{\cdot}62°$, and this rises after some days to a constant value $[\alpha]_D = -51{\cdot}52°$. The corresponding p-*tolylazo*-compound,—

$$C_6H_4Me\cdot N_2\cdot CHAc\cdot CO_2\cdot C_{10}H_{19},$$

melts at 86—87°, and in benzene has $[\alpha]_D = -11{\cdot}86°$ changing to $-61{\cdot}56°$; with phenylhydrazine, it yields p-*methylphenyl*-4-*azo*-1-*phenyl*-3-*methyl*-5-*pyrazolone*,—

$$\begin{array}{l} CMe{:}N\text{——}\text{——}\cdot NPh \\ | \qquad\qquad\quad | \\ CH(N_2\cdot C_6H_4Me)\cdot CO \end{array},$$

which forms yellow or orange needles melting at 136—137°.

Menthyl p-*bromophenylazoacetoacetate*,—

$$C_6H_4Br\cdot N_2\cdot CHAc\cdot CO_2\cdot C_{10}H_{19},$$

melts at 119—121°, and in benzene solution has $[\alpha]_D = -12{\cdot}84°$, changing to $-46{\cdot}88$; with phenylhydrazine, it gives rise to 4-*bromophenylazo*-1-*phenyl*-3-*methyl*-5-*pyrazolone*,—

$$\begin{array}{l} CMe{:}N\text{——}\text{——}\cdot NPh \\ | \qquad\qquad\quad | \\ CH(N_2\cdot C_6H_4Br)\cdot CO \end{array},$$

which melts at 152—153°.

Menthyl p-*chlorophenylazoacetoacetate*,—

$$C_6H_4Cl\cdot N_2\cdot CHAc\cdot CO_2\cdot C_{10}H_{19},$$

melts at 103—105°, and in benzene has $[\alpha]_D = -15{\cdot}43°$ changing to $-55{\cdot}79°$; with phenylhydrazine, it gives 4-p-*chlorophenylazo*-1-*phenyl*-3-*methyl*-5-*pyrazolone* melting at 141—142°.

The mutarotation of the above compounds is accelerated by traces of bases or acids. By the action of diazo-oxides on the esters, formazyl compounds are formed. The following have been isolated, but the colour of their solutions is too intense to admit of the determination of their rotatory power.

Menthyl pp'-*dimethylphenylformazylcarboxylate*,—

$$C_6H_4Me\cdot NH\cdot N{:}C(N_2C_6H_4Me)\cdot CO_2\cdot C_{10}H_{19},$$

forms dark red crystals with a blue reflex, and melts at 134—136°; *menthyl* p-*bromophenyl*-p'-*methylphenylformazylcarboxylate* melts at 149—151°; *menthyl* p-*chlorophenyl*-p'-*methylphenylformazylcarboxylate* melts at 145—147°.

The mutarotation of the azo-derivatives of menthyl acetoacetate is due to *iso*dynamic change in virtue of the lability of the α-hydrogen atom, and when this hydrogen atom is replaced by bromine the specific rotation becomes invariable. The α bromo-derivatives, which represent a new class of azo-compounds, were made (1) by direct bromination of the above esters, (2) by the interaction of a diazo oxide and menthyl α-bromoacetoacetate.

Menthyl phenylazo-α-bromoacetoacetate,—

$$C_6H_5\cdot N_2\cdot CBrAc\cdot CO_2\cdot C_{10}H_{19},$$

forms large, yellow crystals melting at 133—134°; it has $[\alpha]_D = -82{\cdot}45°$ in benzene. The corresponding p-*tolylazo*-compound, $C_6H_4Me\cdot N_2\cdot CBrAc\cdot CO_2\cdot C_{10}H_{19}$, melts at 155—156°, and has $[\alpha]_D = -85{\cdot}95°$. The p-*bromophenylazo*-compound, $C_6H_4Br\cdot N_2\cdot CBrAc\cdot CO_2\cdot C_{10}H_{19}$, melts at 155°, and has $[\alpha]_D = -73{\cdot}45°$; the p-*chlorophenylazo*-compound melts at 147—148°; it has $[\alpha]_D = -67{\cdot}61°$. The crystals of these four compounds exhibit anomalous dispersion of the optic axes.

The following note has been received since the meeting:—

82. "*The Chemical Reactions Involved in the Rusting of Iron.*" By W. R. Dunstan.

In a lecture delivered before the Royal Artillery Institution at Woolwich, the substance of which was published in the *Proceedings* of that Institution (1899, vol. xxvi., No. 5), and also in *Engineering*, June 1, 1900, the author gave a general account of the results of an investigation of the chemical process of rusting. This investigation, which was conducted with the co-operation of Dr. Jowett, was afterwards continued, and with the assistance of Mr. E. Goulding extended, especially to the atmospheric corrosion of iron and steel, and a further account of the results obtained was published in the Report (1900) of the Steel Rails Committee of the Board of Trade, of which the author was a member. Since then, the inquiry has been further extended, especially with reference to the atmospheric corrosion of pairs of metals, and to the elucidation of the general process. Various circumstances have, however, delayed the completion of the work, and the present summary of the results is published pending the preparation of a fuller account of the investigation.

It has been proved that whilst both liquid water and oxygen are necessary for the formation of rust, the presence of carbonic acid is not essential, although it may accelerate the action. The well-known effect of alkalis and alkaline salts in preventing the oxidation of iron has been hitherto attributed to the withdrawal of the carbonic acid. It has been found, however, that the phenomenon is not due to this cause, but to the establishment of conditions in which the production of hydrogen peroxide is inhibited.

When highly purified iron, containing mere traces of impurity, is left in contact with dry gases (oxygen, carbon dioxide, mixtures of oxygen and carbon dioxide), rusting does not take place. In the presence of the same gases and water vapour, no rusting occurs so long as a constant temperature (34° in the actual experiments) is maintained, but if the temperature is allowed to fluctuate, liquid water condenses on the surface of the iron and rust is produced. It is thus shown that pure iron is not oxidised in presence of gases and water-vapour only, but that the presence of liquid water is necessary for rusting to take place.

In another series of experiments, pieces of iron were left in contact with water saturated with a particular gas and with an atmosphere of the same gas above the solution. When hydrogen, carbon dioxide, or nitrogen which had been carefully freed from oxygen was employed, rusting did not occur, but if oxygen or a mixture of oxygen and carbon dioxide was used, oxidation took place. From these results, it is evident that for the formation of rust both oxygen and liquid water are required. In the experiments in which a mixture of oxygen and carbon dioxide was used, the results observed indicated that in this case a secondary action proceeds simultaneously.

In order to investigate the influence of solutions of various salts on the production of rust, small pieces of highly purified sheet iron were enclosed with the different solutions in sealed glass tubes, the space above the solution in each case being filled with pure oxygen. The following substances were found to prevent to a greater or less extent the formation of rust:—Sodium carbonate, ammonium carbonate, borax, disodium hydrogen phosphate, calcium hydroxide, ammonia, potassium dichromate, potassium ferrocyanide, chromic acid, sodium nitrite, and potassium carbonate. Rusting occurred in the presence of the following compounds:—Sodium chloride, potassium chlorate, ferrous sulphate, potassium ferricyanide, potassium nitrate, and sodium sulphate. The reagents which prevent the rusting of iron are those in presence of which decomposition of hydrogen peroxide takes place, and which are consequently inimical to its formation. There can be little doubt, therefore, that hydrogen peroxide plays an important part in the chemical process of rusting. By the direct action of hydrogen peroxide on metallic iron, a red basic ferric hydroxide, identical with ordinary rust, is rapidly produced, and it is found that in general those metals rust in air which are oxidised by hydrogen peroxide, whilst those metals which are not oxidised by hydrogen peroxide do not rust in air. Iron, zinc, and lead are examples of the first class, and the rusting of all these metals is stopped by contact with substances which prevent the formation of hydrogen peroxide. Copper, silver, and nickel are examples of the second class; these metals do not rust in air, and are not oxidised by hydrogen peroxide.

The analysis of a number of specimens of iron rust has shown that its composition may be represented by the formula $Fe_2O_2(OH)_2$.

The chemical reactions concerned in the process of rusting may therefore be represented by the following equations:—

$$Fe + O_2 + H_2O = FeO + H_2O_2.$$
$$2FeO + H_2O_2 = Fe_2O_2(OH)_2.$$

The presence of water in the liquid state is essential alike for the occurrence of rusting and for the formation of hydrogen peroxide.

In the case of certain metals, notably that of zinc, hydrogen peroxide can be detected during the process of rusting. It has not been possible, however, to detect with certainty the presence of hydrogen peroxide during the rusting of iron. This may be due to the fact, previously mentioned, that iron is very rapidly oxidised by hydrogen peroxide with formation of rust, so that under ordinary conditions the hydrogen peroxide is quickly destroyed.

The influence of certain other reactions on the process of rusting has been studied, and may be summarised as follows:—

I. The direct decomposition of water by metallic iron with liberation of hydrogen can take place only at a relatively high temperature, and is not affected by the presence of alkaline salts, such as sodium carbonate.

II. The action of aqueous carbonic acid on iron in the absence of oxygen results in the liberation of hydrogen, and formation of ferrous carbonate or bicarbonate. If oxygen is present, the ferrous salt subsequently undergoes oxidation, the rust obtained in this case containing a varying amount of carbonate.

III. Electrolytic action occurs when the iron is impure or when another metal is present. The electropositive metal suffers oxidation, and hydrogen gas is evolved. This action is not prevented by the presence of sodium carbonate.

PHYSICAL SOCIETY.

Ordinary Meeting, May 22nd, 1903.

Dr. R. T. Glazebrook, F.R.S., President, in the Chair.

Mr. J. Stöttner gave an Exhibition of Nernst Lamps, showing their development from the experimental form up to the most recent types.

Mr. Stöttner commenced by giving a short account of the history of the Nernst lamp, and explained briefly the principle of its action. The oxides used for the glowers are thoria, zirconia, and other rare earths thereto related, such as oxides of yttrium and cerium. A paste of these is formed, and small rods or tubes are pressed through a suitable nozzle. These are hardened and cut into small lengths, and practically the principal part of the lamp is finished. Several of these rods were passed round for the inspection of Fellows. The chief difficulty in the practical lamp is in the design of a durable automatic heater to heat the filament up to conducting point. A number of automatic arrangements which have been designed for disconnecting the heater were shown. Another important part of a Nernst lamp is the bolstering resistance, which in its final development consists of a thin iron wire sealed in a glass bulb filled with hydrogen gas. If a lamp is used without a bolstering resistance, as soon as a certain critical potential is reached the current increases, at first slowly and then quicker and quicker, the potential remaining constant, until the lamp burns itself out. This phenomenon was shown experimentally. Various forms of lamp were exhibited. One with two glowers and one heater overcomes the difficulty of thick glowers. A projection lamp was shown with three glowers in parallel requiring 300 watts. The glowers in this case were heated artificially. Mr. Stöttner also exhibited and described a pole-finder for use with lamps using direct current.

The Chairman said he would like to see details of the life and economy of these lamps under various conditions. The lamp was in its infancy, and probably even more satisfactory lamps would be forthcoming.

Mr. T. H. Blakesley gave an Exhibition of a Diagram for Single-piece Lenses.

The properties of a single-piece lens are determined by four factors:—The two radii of curvature, the thickness of the lens, and the value of the refractive index of the material of which it is composed. In the case of a lens

acid, $P(OH)_2OC_4H_9O_3$, and apparently this compound then fixes a further molecule of phosphorous acid, producing the body $P(OH)_2OCH_2CHOHCHOHCH_2OP(OH)_2$. The prolonged action of heat upon this latter substance gives rise to a volatile solid. Neutral phosphorous ether of erythran, $POHOC_4H_6O$, results from the reaction of the two phosphorous oxyhydriles on the secondary alcohol of erythran. This substance is immediately decomposed by water, giving the acid phosphorous ether of erythran, $P(OH)_2OC_4H_7O_2$, in which a single phosphorous oxyhydrile is contained. Erythrophosphorous acid and acid phosphorous ether of erythran cannot be isolated from their salts, because they are very unstable and are slowly saponified by cold water.

Organic Acids. — Œchsner de Coninck and M. Raynaud.—The authors examine the relative stability of the first acids of the formic series, and explain the mechanism of the decomposition of benzoic and phthalic acids by sulphuric acid.

Heat of Formation of certain Compounds of Barium.—M. Guntz.—The author finds the heat of oxidation of barium by first making a careful determination of the heat of solution of the metal in water. The mean value he obtains for this constant is +92·5 cal., and from this he calculates the heat of oxidation of barium to be +133·4 cal. He also determines the heat of formation of barium hydrate by decomposing a known weight of the hydrate by means of water. The number obtained is +37·5 cal. The heats of formation of the nitride and amide of barium are also found to be respectively +149·4 and 53·3 cal.

Chlorides of Chlorocinnamylidene and Bromocinnamylidene.—Ernest Charon and Edgar Dugoujon.—In a previous paper the authors showed that cinnamylidene chloride behaves as an acid chloride, and as such can be decomposed by water in the cold. They found that this particular property was due to the double liaison of the group $CHCl_2$. In their present research they further show that there is a distinct relation between the non-saturated character of the molecule and the stability of the group $CHCl_2$.

Transformation of Diphenylcarbonic and Monophenylsalicylic Ethers. — R. Fosse. — When phenyl carbonate, $CO_3(C_6H_5)_2$, is heated in presence of neutral sodium carbonate large bubbles of gas are formed, which rise to the surface of the liquid. These consist of carbonic anhydride and vapour of phenol. The reaction begins considerably below the boiling-point of phenylic ether, and it is due to the presence of the Na_2CO_3. The author obtained from the residue either phenylphenoxybenzoate, $C_6H_5—O.C_6H_4.CO_2.C_6H_5$, or phenoxybenzoic acid, $C_6H_5—O.C_6H_4.CO_2H$.

A New Diiodo-phenol.—P. Brenans.—The author investigates a fifth isomer of the diiodo-derivatives of phenol, $C_6H_3—OH—I_2$. 1 . 3 . 4. He obtains this by starting with the mono-iodo paranitraniline, $C_6H_3—NH_2—NO_2—I$. 1 . 4 . 2. The following succession of reactions take place:—(1) The diazo derivative of this iodo-nitraniline is decomposed by means of potassium iodide and changed into diiodo-nitrobenzene, $C_6H_3—NO_2—I_2$. 1 . 3 . 4. (2) The iodo-nitrobenzene is reduced to the corresponding diiodo-aniline, $C_6H_3—NH_2—I_2$. 1 . 3 . 4. (3) Finally, the diazo-sulphate of this base is heated in presence of water and transformed into diiodo-phenol, $C_6H_3—OH—I_2$. 1 . 3 . 4.

New Derived Bases of Pentoses.—E. Roux.—By reducing the oximes of arabinose and xylose by the same method as that previously used by the author for glucose, he obtains the two new bases arabinamine and xylamine.

Action of Alkalis on Glycerin. Application of this Reaction to the Estimation of Glycerin.—A. Buisine.—The author obtains, by the action of glycerin on potash lime, three different reactions, according as the temperature is between 220° and 250°, 250° and 280°, or 280° and 320°. The gas evolved during the process is pure hydrogen, the volume varying considerably in each case. These reactions can be applied to the estimation of glycerin, by measuring the volume of the evolved hydrogen. The author finds the third case, in which the reaction takes place about 320°, is the most satisfactory. The method is easily applied with simple apparatus. On the other hand, it is very sensitive—1 m.grm. of glycerin evolving about 7 c.m. of hydrogen; it is therefore very useful for estimating small quantities of glycerin.

Bulletin de la Société Chimique de Paris.
Series 3, Vol. xxvii., No. 24.

Preparation and Properties of a New Hydride of Silicon.—H. Moissan and S. Smiles.

Further Research on Liquid Hydride of Silicon, Si_2H_6.—H. Moissan and S. Smiles.

Some New Properties of Amorphous Silicon.—H. Moissan and S. Smiles.—The above three papers have been noticed already in these columns.

Research on Silicide of Calcium, $CaSi_2$. — H. Moissan and W. Dilthey.—Already noticed.

Examination of Silicide of Lithium.—H. Moissan.—Already noticed.

The Limits of Combustibility.—L. Pelet and P. Jomini.—When a combustible material is burnt in a confined space containing a definite amount of air the flame soon becomes extinguished. Analyses of the products of combustion show that the proportion of uncombined oxygen present is very variable. The oxygen left and that consumed up to the extinction of various combustible materials, determines the *limit of combustibility*. In the present paper the authors have endeavoured to determine on what factors the limits of combustibility depend in the case of various combustible materials. The following simple substances gave the results printed below when burnt in a confined space of 12 litres:—

	Oxygen consumed. Per cent.	Oxygen remaining. Per cent.
Sulphur, burnt in a dish 5 c.m. diameter	8·24	12·56
Hardwood charcoal	17·43	3 37
Hydrogen, flame 5 c.m. high	19·00	1·80
Magnesium	19·07	1·73
Yellow phosphorus	20·15	0·65

The following carbon compounds were treated in the same manner in a vessel of 7 litres capacity, and the results obtained were—

	Oxygen consumed. Per cent.	Oxygen remaining. Per cent.
Petroleum, in a lamp with a 65 m.m. wick	6·22	14·58
18 m.m. candles	6·68	14·12
Turpentine	8·82	11·98
Camphor	9·42	11·38
Naphthalene	10·10	10·70
Ethylic alcohol at 95°	10·98	9·82
Methylic alcohol	11·33	9·47
Benzene	12·28	8·52
Acetylene	13·86	6·94
Coal-gas	14·68	6·12
Ether	14·94	5·86
Sulphide of carbon	15·63	5·17

These results show that the limit of combustibility varies very considerably with the nature of the material. In the hope of finding the cause of these variations, the authors determined the temperatures of the flames by means of wires of platinum-gold alloys of different compositions. These measurements were only approximate, but they were able to obtain the following series, starting with the substance giving the coolest flame:—(1) Petroleum,

(2) candles, (3) sulphur, (4) alcohol, (5) benzene, (6) coal-gas, (7) carbon, (8) hydrogen, (9) phosphorus. From this it is seen that the higher the temperature of the flame the nearer the limit of combustibility approaches to 20·8 per cent of oxygen consumed. Finally, the authors sum up their results, that the limit of combustibility depends on—(*a*) The nature of the substance; (*b*) the temperature of the flame; (*c*) the amount of gaseous combustible introduced into the flame in a unit of time; and (*d*) the temperature of the surrounding air.

The Solubility of Paraformaldehyde in Solutions of Sulphite of Soda.—A. and L. Lumière and M. Seyewetz.—There are several drawbacks to the use of formaldehyde for the insolubilisation of gelatin, and the authors thought that, owing to its constancy of composition, trioxymethylene or paraformaldehyde, $(H.COH)_3$, might be used instead. For this reason they have examined its solubility in various saline solutions, and find that it is soluble in solutions of sulphite of soda; and that the maximum of solubility of paraformaldehyde is reached when its mixture with anhydrous sulphite of soda contains 30 to 60 per cent of the latter. Thus, we can obtain solutions containing from 25 to 29 per cent of trioxymethylene. The presence of paraformaldehyde in sufficient quantity (25 per cent) increases the solubility of the sulphite of soda, and enables up to about 55 per cent of this substance to be dissolved in water; the solution then contains 74 per cent of solid matter.

Some Properties of Compounds of the Form $R{-}CO{-}O\diagdown\!\diagup CH_2$ **and** $R{-}CO{-}O\diagdown\!\diagup CH_2$. — Marcel Descudé.—The author has examined the action of certain alcohols on chloroacetate of methylene, and finds that methylic alcohol gives dimethylformal and acetate of methyl. Ethylic alcohol gives similar results, as does also propylic alcohol. The alkaline alcoholates react on chloroacetate of methylene with extreme energy, giving rise to an abundant deposit of alkaline chloride. By operating with methylate of sodium, the author hoped to obtain the derivative $CH_3{-}COO\diagdown\!\diagup CH_2$, discovered by M. Friedel; but in this he was not successful.

The Hyposulphites of the Aromatic Amines.—A. Wahl.—Already noticed.

Constitution of the Aloines.—E. Léger.—Already noticed.

Anæstherin: a New Vegetable Cholesterin.—T. Klobb.—The author has extracted from the capitulum of the Roman camomile (*Anthemis nobilis*) a body which he considers ought to be placed among the phytosterines. The analysis of the benzoate of this body gives C = 83·02 and 82·90, H = 10·29 and 10·33; and its formula may be either $C_{28}H_{47}O.C_7H_5O$ or $C_{29}H_{49}O.C_7H_5O$. It occurs in pearly crystals, very soluble in benzene, sulphide of carbon, and chloroform, almost insoluble in cold alcohol, slightly soluble in boiling alcohol and hot petroleum ether. Boiling aqueous potash does not attack it. Anæstherin has several coloured reactions. Cold sulphuric acid gives an orange-red colouration; on evaporation with a little hydrochloric acid or Fe_2Cl_6 and taking up with chloroform, a violet colouration is obtained. By dissolving anæstherin in acetic anhydride, then adding sulphuric acid to the cooled solution, a permanganate-purple colour is obtained.

The Existence of Arsenic in the Animal Series.—G. Bertrand.—The author has examined a number of cetaceous marine birds, fishes, and animals, and finds all, from the higher vertebrates down to the sponges, contain small quantities of arsenic. Therefore the presence of this metalloid is not, as with other elements, at all characteristic of any group of creatures. It is found in all the tissues, and must be looked upon—with carbon, nitrogen, sulphur, or phosphorus—as a fundamental element of protoplasm.

Use of Cane-sugar Yeasts for the Fermentation of Cider.—Henri Alliot.—The author finds, as the result of a number of experiments, that cane sugar yeast is a saccharomycete of slight attenuation, and is quite fit to be used for the preparation of sweet ciders, as it has been shown that, as far as taste is concerned, the cider thus obtained is not different from ciders made with other yeasts.

A New Proof of the Cellular Resistance of the Saccharomycetes, and a New Application of this Property in Distilling Operations.—Henri Alliot.—A certain quantity of molasses is treated with its own weight of water and 4 grms. of sulphuric acid per litre, and placed in a retort. About a fifth of this is distilled over and added, a little at a time, at several hours' interval, to a pure culture of yeast in any sugary nutritive must as used in laboratories. The small initial amount only of the yeast requires to become acclimatised to the temperature (20—25°), and 1 litre is enough for a large distillery fermenting more than 1000 hectolitres of must every day.

MISCELLANEOUS.

Jubilee Presentation to Herr Ludwig Boltzmann.—On February 20th, 1904, Herr Ludwig Boltzmann will reach his sixtieth birthday. It is the intention to take this opportunity, as a token of universal respect and appreciation, of presenting to him a jubilee volume in the preparation of which scientific men throughout the whole world are invited to assist. Full particulars of the undertaking can be obtained from Dr. Stefan Meyer, Wien ix., Turkenstrasse 3.

City and Guilds of London Institute.—The Department of Technology of this Institute are about to hold an Exhibition of Practical Work executed by candidates at the Institute's technological and manual training examinations, 1903, in the North Gallery of the Imperial Institute. The exhibition will be opened on Thursday, June 11th, at 3 p.m. precisely, by the Most Hon. the Marquis of Londonderry, K.G., President of the Board of Education.

Livingstone College.—On Wednesday, June 10th, 1903, the Right Rev. the Lord Bishop of St. Albans will preside at a short meeting, to be held at 3.30 p.m. in the grounds of Livingstone College, on the occasion of the Commemoration Day proceedings. After the meeting the College will be open for inspection. Livingstone College has rendered great services in the past, not only to missionaries, but to all travellers in unhealthy regions, and it is hoped that the present opportunity will lead to much greater interest being taken in the work carried out under its auspices. Admission will be by ticket only, which may be obtained from the Principal, Livingstone College, Leyton, by those who are interested in the College and its work.

The Acetylation of Soluble Starch.—Fritz Pregl.—Franchimont was the first to show (*Comptes Rendus*, vol. lxxxix., p. 711) that the acetylation of cellulose by means of acetic anhydride and concentrated sulphuric acid is effected very easily, but that at the same time there is a rupture of the molecule. The author's experiments on the acetylation of soluble starch were carried out under the same conditions. Five grms. of dry soluble starch, prepared as described by Zulkowsky (*Berichte*, vol. xiii., p. 1395), were suspended in 50 grms. of acetic anhydride; to this was added a mixture of 2·5 c.c. of sulphuric acid and 7·5 c.c. of acetic acid; after forty hours, water was poured in, the precipitate is washed and purified by solution in acetic acid, and precipitation by alcohol. Analysis, as well as the titration of the acetyls, corresponds to a triacetate, $C_6H_7O_5(C_2H_3O)_3$. This derivative, saponified by alcoholic potash, regenerates the soluble starch with which we started, with all its properties. This soluble

starch answers to the formula $C_6H_{10}O_5$, and not to $3C_6H_{10}O_5+H_2O$, given by Lyniewski (*Berichte*, vol. xxx., p. 2415). When we do the acetylation in the presence of more sulphuric acid, a product is formed soluble in hot alcohol, fusing at about 150—155°, with considerable swelling; its rotatory power $[\alpha]_D$ = about +149°. The saponification of the acetylised derivative gives a dextrine. —*Mon. f. Ch.*, vol. xxii., p. 1049.

Action of Zinc on the Alcoholic Solutions of the Halogenised Ketones.—I. Iotsitch.—By the action of zinc powder on the alcoholic solution of dibromacetophenone a crystalline product was obtained which appeared to be acetophenone. Bromhydrate of pulegon is transformed into menthone and pulegon by zinc powder. By treating butylchloral with zinc powder Zarnol has already obtained the chlorocrotonic and crotonic aldehydes. This reaction may be explained in several manners, and it was with the object of elucidating this point that the author has taken up the examination of the action of zinc on the β- and γ-halogen derivatives of the ketones and the aldehydes. Zinc powder reacts very vigorously on the alcoholic solution of trichlorethylideneacetophenone; a crystalline product is formed, fusible at 50—51°, which becomes yellow rapidly in the air, and is transformed into a liquid having a strong odour of the chloride of the acid. Attempts to prepare the acetic ether have not been successful. The elementary analysis points to a composition which would be that of the original compound, less 1 molecule of HCl; $C_6H_5-CO-CH=CH-CCl_3$—HCl. The cryoscopic determination has given 209 for the molecular weight, instead of 213. The return is about 90 per cent. Zinc powder reacts with the same energy on trichlorethylideneacetone, giving a very unstable liquid product, resinifying in the air, and acquiring a strong odour of the chloride of the acid. Analysis points to a composition very close to $CH_3-CO-CH=CH-CCl_3$—HCl. —*Journ. Soc. Phys. Chim. R.*, vol. xxxiv., p. 98.

MEETINGS FOR THE WEEK.

MONDAY, 8th.—Royal Institution, 5. General Monthly Meeting.
FRIDAY, 12th.—Physical, 5. "Some Experiments on Shadows in an Astigmatic Beam of Light," by Prof. S. P. Thompson. "The Positive Ionisation produced by Hot Platinum in Air at Low Pressures," by O. W. Richardson. "On a Method of Determining the Viscosity of Pitch-like Solids," by Prof. F. T. Trouton and E. S. Andrews.

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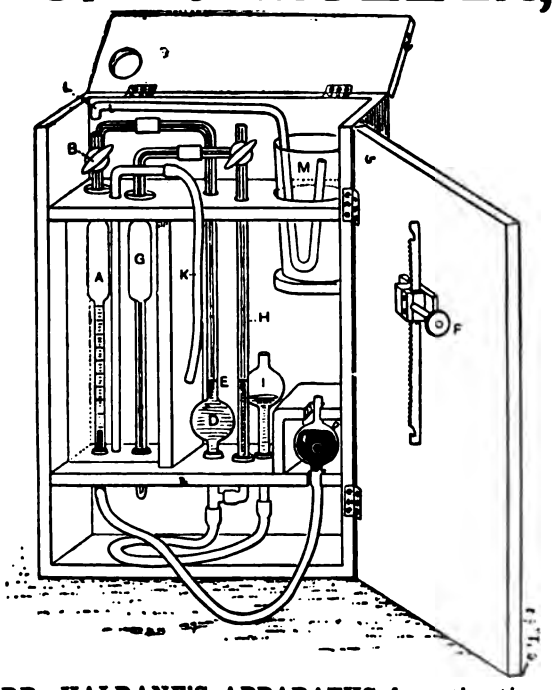

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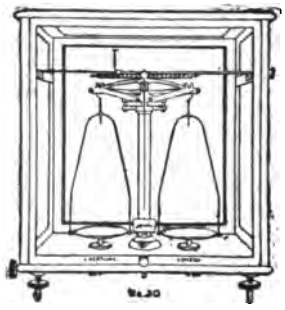

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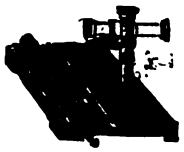

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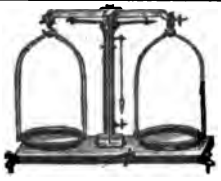

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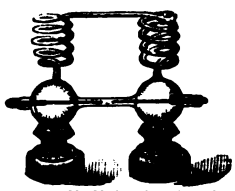

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THE CHEMICAL NEWS.

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MODERN VIEWS ON MATTER:

THE REALISATION OF A DREAM.*

By Sir WILLIAM CROOKES, F.R.S., &c.

FOR nearly a century men who devote themselves to science have been dreaming of atoms, molecules, ultra-mundane particles, and speculating as to the origin of matter: and now to day they have got so far as to admit the possibility of resolving the chemical elements into simpler forms of matter, or even of refining them altogether away into ethereal vibrations or electrical energy.

This dream has been essentially a British dream, and we have become speculative and imaginative to an audacious extent, almost belying our character of a purely practical nation. The notion of impenetrable mysteries has been dismissed. A mystery is a thing to be solved—"and Man alone can master the Impossible." There has been a vivid new start. Our physicists have re-modelled their views as to the constitution of matter and as to the complexity if not the actual decomposability of the chemical elements. To show how far we have been propelled on the strange new road, how dazzling are the wonders that waylay the researcher, we have but to recall—Matter in a fourth state, the genesis of the elements, the dissociation of the chemical elements, the existence of bodies smaller than atoms, the atomic nature of electricity, the perception of electrons, not to mention other dawning marvels far removed from the lines of thought usually associated with English chemistry.

The earliest definite suggestion in the last century of the possible compound nature of the elements occurs in a lecture delivered in 1809 by Sir Humphry Davy at the Royal Institution ("Works of Sir Humphry Davy," vol. viii., p. 325). In that memorable lecture he speculated on the existence of some substance common to all the metals, and he averred that "If such generalisations should be supported by facts, a new, a simple, and a grand philosophy would be the result. From the combination of different quantities of two or three species of ponderable matter we might conceive all the diversity of material substances to owe their constitution."

Again, in 1811, he said (*loc. cit.*, viii., 330):—"It will be useless to speculate upon the consequences of such an advancement in chemistry as that of the decomposition and composition of the metals. . . . It is the duty of a chemist to be bold in pursuit. He must not consider things as impracticable merely because they have not yet been effected. He must not regard them as unreasonable because they do not coincide with popular opinion. He must recollect how contrary knowledge sometimes is to what appears to be experience. . . . To inquire whether the metals be capable of being decomposed and composed is a grand object of true philosophy."

Davy first used the term "Radiant Matter" about 1809, but chiefly in connection with what is now called radiation. He also used the term in another sense, and the following passage in its clear forecast is prophetic of the modern electron (*loc. cit.*, vol. viii., p. 349):—"If particles of gases were made to move in free space with an almost infinitely great velocity—*i.e.*, to become radiant matter—they might produce the different species of rays, so distinguished by their peculiar effects."

In his lectures at the Royal Institution, in 1816, "On the General Properties of Matter," another prescient chemist, Faraday, used similar terms when he said—"If we conceive a change as far beyond vaporisation as that is above fluidity, and then take into account also the proportional increased extent of alteration as the changes rise, we shall, perhaps, if we can form any conception at all, not fall far short of radiant matter; and as in the last conversion many qualities were lost, so here also many more would disappear." Again, in one of his early lectures he strikes a forward note:—"At present we begin to feel impatient, and to wish for a new state of chemical elements. To decompose the metals, to reform them, and to realise the once absurd notion of transmutation, are the problems now given to the chemist for solution."

But Faraday was always remarkable for the boldness and originality with which he regarded generally accepted theories. In 1844 he said, "The view that physical chemistry necessarily takes of atoms is now very large and complicated; first many elementary atoms—next compound and complicated atoms. System within system, like the starry heavens, *may be right*—but may *be all wrong*."

A year later Faraday startled the world by a discovery to which he gave the title "On the Magnetisation of Light and the Illumination of the Magnetic Lines of Force." For fifty years this title was misunderstood and was attributed to enthusiasm or confused ideas. But to-day we begin to see the full significance of the Faraday dream.

It was not till 1896 that Zeeman showed a spectrum line could be acted on by a magnetic field. A spectrum line is caused by motion of the electron acting on the ether, which can only move and be moved by the electron. A magnetic field resolves this motion into other component motions, some slower others quicker, and thus causes a single line to split into others of greater and less refrangibility than the parent line.

In 1879, in a lecture I delivered before the British Association at Sheffield, it fell to my lot to revive "Radiant Matter" ("British Association Reports," Sheffield Meeting, 1879; CHEMICAL NEWS, vol. xl., p. 91; *Phil. Trans. Roy. Soc.*, 1879, Part I., p. 585; *Proc. Roy. Soc.*, 1880, No. 205, p. 469). I advanced the theory that in the phenomena of the vacuum tube at high exhaustions the particles constituting the cathode stream are not solid, nor liquid, nor gaseous, do not consist of atoms propelled through the tube and causing luminous, mechanic, or electric phenomena where they strike, "but that they consist of something much smaller than the atom,—fragments of matter, ultra-atomic corpuscles, minute things, very much smaller, very much lighter than atoms,—things which appear to be the foundation stones of which atoms are composed" (Sir O. Lodge, *Nature*, vol. lxvii., p. 451).

I further demonstrated that the physical properties of radiant matter are common to all matter at this low density—"Whether the gas originally under experiment be hydrogen, carbon dioxide, or atmospheric air, the phenomena of phosphorescence, shadows, magnetic deflection, &c., are identical." Here are my words written nearly a quarter of a century ago:—"We have actually touched the border land where matter and force seem to merge into one another—the shadowy realm between the known and unknown ("Matter is but a mode of motion," *Proc. Roy. Soc.*, No. 205, p. 472). I venture to think that the greatest scientific problems of the future will find their solution in this borderland, and even beyond; here, it seems to me, lie ultimate realities, subtle, far reaching, wonderful."

It was not till 1881 that J. J. Thomson established the basis of the electro-dynamic theory. In a very remarkable memoir in the *Philosophical Magazine* he explained the phosphorescence of glass under the influence of the cathode stream by the nearly abrupt changes in the magnetic field arising from the sudden stoppage of the cathode particles.

The now generally accepted view that our chemical elements have been formed from one primordial substance

* An Address delivered before the Congress of Applied Chemistry at Berlin, June 5, 1903.

was advocated in 1888 by me when President of the Chemical Society, in connection with a theory of the Genesis of the Elements (Pres. Address to Chem. Soc., March 28th, 1888). I spoke of "an infinite number of immeasurably small ultimate—or, rather, ultimatissimate—particles gradually accreting out of the formless mist, and moving with inconceivable velocity in all directions."

Pondering on some of the properties of the rare elements, I strove to show that the elementary atoms themselves might not be the same now as when first generated—that the primary motions which constitute the existence of the atom might slowly be changing, and even the secondary motions which produce all the effects we can observe—heat, chemic, electric, and so forth—might in a slight degree be affected; and I showed the probability that the atoms of the chemical elements were not eternal in existence, but shared with the rest of Creation the attributes of decay and death.

The same idea was expanded at a lecture I delivered at the Royal Institution in 1887, when it was suggested that the atomic weights were not invariable quantities.

I might quote Mr. Herbert Spencer, Sir Benjamin Brodie, Professor Graham, Sir George Stokes, Sir William Thomson (now Lord Kelvin), Sir Norman Lockyer, Dr. Gladstone, and many other English *savans* to show that the notion—not necessarily of the decomposability but at any rate of the complexity of our supposed elements—has long been "in the air" of science, waiting to take more definite development. Our minds are gradually getting accustomed to the idea of the genesis of the elements, and many of us are straining for the first glimpse of the resolution of the chemical atom. We are eager to enter the portal of the mysterious region too readily ticketed "Unknown and Unknowable."

Another phase of the Dream now demands attention. I come to the earlier glimpses of the electric theory of matter.

Passing over the vaguer speculations of Faraday and the more positive speculations of Sir William Thomson (now Lord Kelvin), one of the earliest definite statements of this theory is given in an article in the *Fortnightly Review* for June, 1875, by W. K. Clifford—a man who in common with other pioneers shared that "noblest misfortune of being born before his time." "There is great reason to believe," said Clifford, "that every material atom carries upon it a small electric current, *if it does not wholly consist of this current.*"

In 1886 when President of the Chemical Section of the British Association, in a speculation on the origin of matter, I drew a picture of the gradual formation of the chemical elements by the workings of three forms of energy—electricity, chemism, and temperature—on the "formless mist" (protyle*), wherein all matter was in the pre-atomic state—potential rather than actual. In this scheme the chemical elements owe their stability to their being the outcome of a struggle for existence—a Darwinian development by chemical evolution—a survival of the most stable. Those of lowest atomic weight would first be formed, then those of intermediate weight, and finally the elements having the highest atomic weights, such as thorium and uranium. I spoke of the "dissociation point" of the elements." "What comes after uranium?" I asked. And I answered back—"The result of the next step will be . . . the formation of . . . compounds the dissociation of which is not beyond the powers of our terrestrial sources of heat." A dream less than twenty years ago, but a dream which daily draws nearer to entire and vivid fulfilment. I will presently show you that radium, the next after uranium, does actually and spontaneously dissociate.

The idea of units or atoms of electricity—an idea hitherto floating intangibly like helium in the sun—can now be brought to earth and submitted to the test of experiment.* Faraday, W. Weber, Laurentz, Gauss, Zöllner, Hertz, Helmholtz, Johnstone Stoney, Sir Oliver Lodge, have all contributed to develope the idea—originally due to Weber—which took concrete form when Stoney showed that Faraday's law of electrolysis involved the existence of a definite charge of electricity associated with the ions of matter. This definite charge he called an electron. It was not till some time after the name had been given that electrons were found to be capable of existing separately.

In 1891, in my Inaugural Address as President of the Institution of Electrical Engineers,† I showed that the stream of cathode rays near the negative pole was always negatively electrified, the other contents of the tube being positively electrified, and I explained that "the division of the molecule into groups of electro-positive and electro-negative atoms is necessary for a consistent explanation of the genesis of the elements." In a vacuum tube the negative pole is the entrance and the positive pole the exit for electrons. Falling on a phosphorescent body, yttria, for instance,—a collection of Hertz molecular resonators—the electrons excite vibrations of, say, 550 billion times a second, producing ether waves of the approximate length of 5·75 ten-millionths of a millimetre, and occasioning in the eye the sensation of citron-coloured light. If, however, the electrons dash against a heavy metal, they produce ether waves of a far higher frequency than light, and are not continuous vibrations, but, according to Sir George Stokes, simple shocks or solitary impulses; more like discordant shouts as compared with musical notes.

During that Address an experiment was shown which went far to prove the dissociation of silver into electrons and positive atoms.‡ A silver pole was used, and near it in front was a sheet of mica with a hole in its centre. The vacuum was very high, and when the poles were connected with the coil, the silver being negative, electrons shot from it in all directions, and passing through the hole in the mica screen, formed a bright phosphorescent patch on the opposite side of the bulb. The action of the coil was continued for some hours, to volatilise a certain portion of the silver. Silver was seen to be deposited on the mica screen only in the immediate neighbourhood of the pole; the far end of the bulb, which had been glowing for hours from the impact of electrons, being free from silver deposit. Here, then, are two simultaneous actions. Electrons, or Radiant Matter shot from the negative pole, caused the glass against which they struck to glow with phosphorescent light. Simultaneously, the heavy positive ions of silver, freed from negative electrons, and under the influence of the electrical stress, likewise flew off and were deposited in the metallic state near the pole. The

* We require a word, analogous to protoplasm, to express the idea of the original primal matter existing before the evolution of the chemical elements. The word I venture to use is composed of πρό (*earlier than*) and ὕλη (*the stuff of which things are made*).

* "The equivalent weights of bodies are simply those quantities of them which contain equal quantities of electricity; . . . It being the ELECTRICITY which *determines* the equivalent number, *because* it determines the combining force. Or, if we adopt the atomic theory or phraseology, then the atoms of bodies which are equivalents to each other in their ordinary chemical action, have equal quantities of electricity naturally associated with them."—FARADAY's "Experimental Researches in Electricity," par. 869, Jan., 1834.

"This definite quantity of electricity we shall call the molecular charge. If it were known it would be the most natural unit of electricity."—CLERK MAXWELL's "Treatise on Electricity and Magnetism," First Edition, vol. i., 1873. p. 311.

"Nature presents us with a single definite quantity of electricity. . . . For each chemical bond which is ruptured within an electrolyte a certain quantity of electricity traverses the electrolyte, which is the same in all cases."—G. JOHNSTONE STONEY, "On the Physical Units of Nature," British Association Meeting, Section A, 1874.

"The same definite quantity of either positive or negative electricity moves always with each univalent ion, or with every unit of affinity of a multivalent ion."—HELMHOLTZ, Faraday Lecture, 1881.

"Every monad atom has associated with it a certain definite quantity of electricity; every dyad has twice this quantity associated with it; every triad three times as much, and so on."—O. LODGE, "On Electrolysis," *British Association Report*, 1885.

† "Electricity in Transitu: from Plenum to Vacuum" (*Journ. Inst. Electrical Engineers*, vol. xx., p. 10, January 15, 1891).

‡ In describing the experiment, one of fundamental importance, modern terms are employed.

ions of metal thus deposited in all cases showed positive electrification (*Proc. Roy. Soc.*, vol. lxix., p. 421).

In the years 1893-4-5 a sudden impulse was given to electric vacuum work by the publication in Germany of the remarkable results obtained by Lenard and Röntgen, who showed that the phenomena inside the vacuum tube were surpassed in interest by what took place outside. It is not too much to say that from this date that what had been a scientific conjecture became a sober reality.

One important advance in theoretic knowledge has been obtained by Dewar, the successor of Faraday in the classic laboratories of the Royal Institution. Soon after Röntgen's discovery Dewar found that the relative opacity to the Röntgen rays was in proportion to the atomic weights of bodies, and he was the first to apply this principle to settling a debated point in connection with argon. Argon is relatively more opaque to the Röntgen rays than either oxygen, nitrogen, or sodium, and from this Dewar inferred that the atomic weight of argon was twice its density relative to hydrogen. In the light of to-day's researches on the constitution of atoms, it is impossible to overestimate the importance of this discovery.

In 1896 Becquerel, pursuing the masterly work on phosphorescence inaugurated by his illustrious father, showed that the salts of uranium constantly emit emanations which have the power of penetrating opaque substances and of affecting a photographic plate in total darkness, and of discharging an electrometer. In some respects these emanations, known as Becquerel rays, behave like rays of light, but they also resemble Röntgen rays. Their real character has only recently been ascertained, and even now there is much that is obscure and provisional in the explanation of their constitution and action.

Following closely upon Becquerel's work came the brilliant researches of M. and Mdme. Curie, on the radioactivity of bodies accompanying uranium.

Hitherto I have been recounting isolated instances of scientific speculation with apparently little relation to one another. The existence of matter in an ultra-gaseous state; material particles smaller than atoms; the existence of electrical atoms or electrons; the constitution of Röntgen rays and their passage through opaque bodies; the emanations from uranium; the dissociation of the elements—all these isolated hypotheses are now focussed and welded into one harmonious theory by the discovery of Radium.

> "Often do the spirits
> Of great events stride on before the events,
> And in to-day already walks to-morrow."

No new discovery is ever made without its influence ramifying in all directions and explaining much that before had been mystifying. Certainly no discovery of modern times has had such wide-embracing consequences, and thrown such a flood of light on broad regions of hitherto inexplicable phenomena, as this discovery of M. and Mdme. Curie and M. Bémont, who patiently and laboriously plodded along a road bristling with difficulties almost insuperable to others who, like myself, have toiled in similar labyrinths of research. The crowning point of these labours is Radium.

Let me briefly recount some of the properties of Radium, and show how it reduces speculations and dreams, apparently impossible of proof, to a concrete form.

Radium is a metal of the calcium, strontium, and barium group. Its atomic weight according to C. Runge and J. Precht is probably about 258. In this case it occupies the third place below barium in my lemniscate spiral scheme of the elements, two unoccupied gaps intervening (*Proc. Roy. Soc.*, vol. lxiii, p. 408).

The spectrum of radium has several well-defined lines; these I have photographed and have also measured their wave-lengths. Two especially are strong and characteristic. One at wave-length 3649·71 and the other at wave-length 3814·58. These lines enable radium to be detected spectroscopically.

The most striking property of radium is its power to pour out torrents of emanations bearing a certain resemblance to Röntgen rays, but differing in important points.

The emanations of radium cause soda-glass to assume a violet colour, and they produce many chemical changes. Their physiological action is strong, a few milligrammes brought near the skin in a few hours producing a wound difficult to heal.

The emanations from radium are of three kinds. One set is the same as the cathode stream, now identified with free electrons—atoms of electricity projected into space apart from gross matter—identical with "matter in the fourth or ultra-gaseous state." Kelvin's "satellites," Thomson's "corpuscles" or "particles"; Lodge's "disembodied ionic charges, retaining individuality and identity." These electrons are neither ether-waves, nor a form of energy, but substance possessing inertia (probably electric). Liberated electrons are exceedingly penetrating. They will discharge an electroscope when the radium is ten feet or more away, and will affect a photographic plate, through five or six mm. of lead and several inches of wood or aluminium. They are not readily filtered out by cotton-wool; they do no not behave as a gas, *i.e.*, they have not properties dependent on intercollisions, mean free path, &c.; they act more like a fog or mist, are mobile and carried about by a current of air to which they give temporary conducting powers, clinging to positively electrified bodies and thereby losing mobility and diffusing on the walls of the containing vessel if left quiet.

Electrons are deviable in a magnetic field. They are shot from radium with a velocity of about one-tenth that of light, but are gradually obstructed by collisions with air atoms, so that some become much slowed, and then are what I formerly called loose and erratic particles, which diffuse about in the air, and give it temporary conducting powers. These can turn corners, can be concentrated by mica cones into a bundle and then produce phosphorescence.

Another set of emanations from radium are not affected by an ordinarily powerful magnetic field, and are incapable even of passing through thin material obstructions. These emanations have about one thousand times the energy of those radiated by the deflectable particles. They render air a conductor and act strongly on a photographic plate. Their mass is enormous in comparison with that of the electrons, and their velocity is probably as great when they leave the radium, but, in consequence of their greater mass, they are less deflected by the magnet, are easily obstructed by obstacles, and are sooner brought to rest by collisions with air atoms. The Hon. R. B. Strutt (*Phil. Trans. R. S.*, A, 1901, vol. cxcvi., p. 525) was the first to affirm that these non-deflectable rays are the positive ions moving in a stream from the radio-active body.

Rutherford has shown that these emanations are slightly affected in a very powerful magnetic field, but in an opposite direction to the negative electrons. They are therefore proved to be positively charged bodies moving with great velocity. For the first time Rutherford has measured their speed and mass, and he shows they are ions of matter moving with a speed of the order of that light.

There is also a third kind of emanation produced by radium. Besides the highly penetrating rays deflected by a magnet, there are very penetrating rays not at all affected by magnetism. These accompany the previous emanations, and are Röntgen rays—ether vibrations—produced as secondary phenomena by the sudden arrest of velocity of the electrons by solid matter, producing a series of Stokesian "pulses" or explosive ether waves shot into space.

Many lines of argument and research tending towards the same point give trustworthy data by which to calculate the masses and velocities of these different particles. I must deal with big figures, but big and little are relative, and are only of importance in relation to the limitations of

our senses. I will take as the standard the atom of hydrogen gas—the smallest material body hitherto recognised. The mass of an electron is 1/700th of an atom of hydrogen, or 3×10^{-24} grm. according to J. J. Thomson, and its velocity is 2×10^{9} centimetres per second, or two-thirds that of light. The kinetic energy per milligramme is 10^{17} ergs, about three and a-half million foot-tons. Becquerel has calculated that one square centimetre of radio active surface would radiate into space one gramme of matter in one billion years.

The positively electrified masses or ions are enormously great in comparison with the size of the electron. Sir Oliver Lodge illustrates it thus:—If we imagine an ordinary sized church to be an atom of hydrogen, the electrons constituting it will be represented by about 700 grains of sand each the size of an ordinary full-stop (350 positive and 350 negative) dashing in all directions inside, or, according to Lord Kelvin, rotating with inconceivable velocity. Put in another way; the sun's diameter is about one and a-half million kilometres, and that of the smallest planetoid about 24 kilometres. If an atom of hydrogen be magnified to the size of the sun, an electron will be about two-thirds the diameter of the planetoid.

The extreme minuteness and sparseness of the electrons in the atom account for their penetration. While the more massive ions are stopped by intercollisions in passing among atoms, so that they are almost completely arrested by the thinnest sheet of matter, electrons will pass almost unobstructed through ordinary opaque bodies.

The action of these emanations on phosphorescent screens is different. The electrons strongly affect a screen of barium platinocyanide, but only slightly one of Sidot's zinc sulphide. On the other hand, the heavy, massive, non-deflectable positive ions affect the zinc sulphide strongly, and the barium platinocyanide screen in a much less degree.

Both Röntgen rays and electrons act on a photographic plate and produce images of metal and other substances enclosed in wood and leather, and throw shadows of bodies on a barium platinocyanide screen. Electrons are much less penetrating than Röntgen rays, and will not, for instance, show easily the bones of the hand. A photograph of a closed case of instruments is taken by radium emanations in three days, and by Röntgen rays in three minutes. The resemblance between the two pictures is slight, and the differences great.

The power with which radium emanations are endowed of discharging electrified bodies is due to the ionisation of the gas through which they pass. This can be effected in many other ways; thus, ionisation is communicated to gases faintly by the splashing of water, by flames and red hot bodies, by ultra-violet light falling on negatively electrified metals, and strongly by the passage of Röntgen rays.

According to Sir Oliver Lodge's Electronic Theory of Matter, a chemical atom or ion has a few extra negative electrons in addition to the ordinary neutral atom, and if these negative electrons are removed it thereby becomes positively charged. The free electron portion of the atom is small in comparison with the main bulk, in the proportion in hydrogen of about 1 to 700. The negative charge consists of super-added or unbalanced electrons,—one, two, three, &c., according to the chemical valency of the body,—whereas the main bulk of the atom consists of paired groups, equal positive and negative. As soon as the excess electrons are removed, the rest of the atom, or ion, acts as a massive positively charged body, hanging tightly together. In a high vacuum the induction spark tears the components of a rarefied gas apart; the positively charged ions, having great comparative density are soon slowed down by collisions, while the electrons are driven from the negative pole with an enormous velocity depending on the initial electromotive force and the pressure of gas inside the tube, but approaching, at the highest exhaustions, half that of light.

After leaving the negative pole the electrons meet with a certain resistance, in a slight degree by physical collisions, but principally by reunion with the positive ions.

Since the discovery of radium and the identification of one set of its emanations with the cathode stream or radiant matter of the vacuum tube, speculation and experiment have gone hand in hand, and the two-fluid theory of electricity is gradually replaced by the original one-fluid theory of Franklin. On the two-fluid theory, the electrons constitute free negative electricity, and the rest of the chemical atom is charged positively, although a free positive electron is not known. It seems to me simpler to use the original one-fluid theory of Franklin, and to say that the electron is the atom or unit of electricity. Fleming uses the word "co electrons" to express the heavy positive ion after separation from the negative electron:—"We can no more," he says, "have anything which can be called electricity apart from corpuscles than we can have momentum apart from moving matter." A so-called negatively charged chemical atom is one having a surplus of electrons, the number depending on the valency, whilst a positive ion is one having a deficiency of electrons. Differences of electrical charge may thus be likened to debits and credits in one's banking account, the electrons acting as current coin of the realm. On this view only the electron exists; it is the atom of electricity, and the words positive and negative, signifying excess and defect of electrons, are only used for convenience of old-fashioned nomenclature.

The electron theory fits and luminously explains Ampère's idea that magnetism is due to a rotating current of electricity round each atom of iron; and following these definite views of the existence of free electrons, has arisen the electronic theory of Matter. It is recognised that electrons have the one property which has been regarded as inseparable from matter—nay, almost impossible to separate from our conception of matter,—I mean inertia. Now, in that remarkable paper of J. J. Thomson's published in 1881, he developed the idea of electric inertia (self-induction) as a reality due to a moving charge. The electron therefore appears only as apparent mass by reason of its electro-dynamic properties, and if we consider all forms of matter to be merely congeries of electrons, the inertia of matter would be explained without any material basis. On this view the electron would be the "protyle" of 1886, whose different groupings cause the Genesis of the Elements.

There is one more property of the emanations of radium to bring before your notice. I have shown that the electrons produce phosphorescence of a sensitive screen of barium platinocyanide, and the positive ions of radium produce phosphorescence of a screen of zinc blende.

If a few minute grains of radium salt fall on the zinc sulphide screen the surface is immediately dotted with brilliant specks of green light. In a dark room, under a microscope with a ½-inch objective, each luminous spot shows a dull centre surrounded by a diffused luminous halo. Outside the halo the dark surface of the screen scintillates with sparks of light. No two flashes succeed on the same spot, but are scattered over the surface, coming and going instantaneously, no movement of translation being seen.

If a solid piece of radium salt is brought near the screen, and the surface examined with a pocket lens magnifying about 20 diameters, scintillating spots are sparsely scattered over the surface. Bringing the radium nearer the screen the scintillations become more numerous and brighter, until when close together the flashes follow so quickly that the surface looks like a turbulent luminous sea. When the scintillating points are few there is no visible residual phosphorescence, and the successive sparks appear "atoms of intensest light," like stars on a black sky. What to the naked eye seems like a uniform "milky way," under the lens becomes a multitude of stellar points, flashing over the whole surface.

"Polonium" basic nitrate, actinium, and radio-active platinum produce a similar effect on the screen, but the

scintillations are fewer. In a vacuum the scintillations are as bright as in air, and being due to inter-atomic motion they are not affected by extremes of low temperature: in liquid hydrogen they are as brilliant as at the ordinary temperature.

A convenient way to show these scintillations is to fit the blende screen at the end of a brass tube with a speck of radium salt in front about a millimetre off, and to have a lens at the other end. I propose to call this little instrument the "Spinthariscope," from the Greek word σπινθαρίς,* a scintillation.

It is difficult to estimate the number of flashes of light per second. With the radium about five centimetres off the screen the flashes are barely detectable, not more than one or two per second. As the distance of the radium diminishes, the flashes become more frequent, until at one or two centime. they are too numerous to count, although it is evident this is not of an order of magnitude inconceivably great.

Practically the whole of the luminosity on the blende screen, whether due to radium or "polonium," is occasioned by emanations which will not penetrate card. These are the emanations which cause the scintillations, and the reason why they are distinct on the blende and feeble on the platinocyanide screen, is that with the latter the sparks are seen on a luminous ground of general phosphorescence which renders the eye less able to see the scintillations.

It is probable that in these phenomena we actually witness the bombardment of the screen by the positive ions hurled off by radium with a velocity of the order of that of light. Each particle is rendered apparent only by the enormous extent of lateral disturbance produced by its impact on the sensitive surface, just as individual drops of rain falling on a still pool are not seen as much, but by reason of the splash they make on impact, and the ripples and waves they produce in ever-widening circles.

Indulging in a "Scientific Use of the Imagination," and pushing the hypothesis of the electronic constitution of Matter to what I consider its logical limit, we may be, in fact, witnessing a spontaneous dissociation of radium—and we begin to doubt the permanent stability of matter. The chemical atom may be actually suffering a katabolic transformation; but at so slow a rate that supposing a million atoms fly off every second, it would take a century for weight to diminish by one milligramme.

It must never be forgotten that theories are only useful so long as they admit of the harmonious correlation of facts into a reasonable system. Directly a fact refuses to be pigeon-holed and will not be explained on theoretic grounds, the theory must go, or it must be revised to admit the new fact. The Nineteenth century saw the birth of new views of atoms, electricity, and ether. Our views to-day of the constitution of matter may appear satisfactory to us, but how will it be at the close of the Twentieth century? Are we not incessantly learning the lesson that our researches have only a provisional value? A hundred years hence shall we acquiesce in the resolution of the material universe into a swarm of rushing electrons?

This fatal quality of atomic dissociation appears to be universal and operates whenever we brush a piece of glass with silk; it works in the sunshine and raindrops, and in the lightnings and flame; it prevails in the waterfall and the stormy sea. And although the whole range of human experience is all too short to afford a parallax whereby the date of the extinction of Matter can be calculated, Protyle, the "formless mist," once again may reign supreme, and the hour hand of eternity will have completed one revolution.

* Ἐνθ' ἐκ νηὸς ὄρουσεν ἄναξ, ἑκάεργος Ἀπόλλων,
ἀστὴρ εἰδόμενος, μέσῳ ἠματι τοῦ δ' ἀπὸ πολλαὶ
σπινθαρίδες πωτῶντο, σέλας δ' εἰς οὐρανὸν ἵκεν'.

(Here from the ship leaped the far-darting Lord Apollo, like a star at midday, while from him flitted scintillations of fire, and the brilliancy reached to heaven.—Homer's *Hymn to Apollo*, lines 440—442.

A NEW CLASS OF PERURANATES.

By. J. ALOY.

When we add peroxide of hydrogen to a soluble salt of uranium, a white precipitate of peruranic hydrate is produced. But if we operate in the presence of alkali we obtain, on the contrary, a solution which deposits yellow crystals of peruranates spontaneously, or better in the presence of alcohol. The composition of these different compounds is being still vigorously discussed. While most writers give peruranic oxide the formula UO_4, Fairley, who discovered it, looks upon it as a mixed oxide, $UO_6(UO_3)_2$ (*Chem. Soc.*, vol. i.. p. 127). As for the yellow peruranates, according to Melikoff and Pissarjewski (*Journ. Soc. Phys. Chim. R.*, 1898, vol. xxx., p. 103), they result from the union of UO_4 with the peroxides, such as Na_2O_2.

The solution which gives rise to the formation of the peruranates always has a more or less pronounced red colour; Fairley attributed this colouration to the formation of a red peroxidised salt. In fact, by using small quantities of soda, under conditions which he did not fully explain, he obtained a red oil, which he regarded as a mixed salt of uranium and sodium. He was not able to prepare the corresponding potassium salt.

In reality, the red oil spoken of by Fairley is a solution of a solid peruranate that I have succeeded in isolating. I showed, firstly, that by substituting alkaline carbonates for the alkalis, it is very easy to produce red solutions of the peruranates. This reaction even forms one of the best characteristic tests for salts of uranium, and can be used also for detecting the presence of peroxide of hydrogen (Aloy, *Bull. Soc. Chim.*, Series 3, vol. xxvii., p. 734). Following this, I prepared the solid peruranates by several methods. I will describe the two following methods, as being easy of application:—

1. A solution of nitrate of uranium is treated with peroxide of hydrogen in sufficient quantity to precipitate the whole of the metal; wash by decantation and add some solid alkaline carbonate. In this manner we obtain a red solution which, when treated with ordinary alcohol, gives a red oil analogous to that described by Fairley. The excess of carbonate is removed by treatment with dilute methylic alcohol, which separates the peruranate in the crystalline form. It is always difficult, however, to remove the last traces of the carbonate by this method.

2. To obtain the pure salt it is preferable to proceed in the following manner:—The peruranic hydrate is suspended in peroxide of hydrogen, and a small quantity of alcohol added. To this mixture the alkali, free from carbonate, is added, while stirring continuously. First of all, a very abundant precipitate is formed; this disappears gradually, and there remains at the bottom of the beaker a red substance, which adheres to the sides very persistently. The beaker is turned over to separate the solid from the solution, and then treated several times with pure methylic alcohol. The peruranate becomes detached from the sides and takes a crystalline form.

This method is applicable to the salts of potassium and sodium; it is not so successful in the case of barium.

The peruranates formed in this manner are red, crystalline, very heavy solids. They are rather unstable and lose oxygen slowly at the ordinary temperature; at 100° the decomposition is rapid and complete.

They are destroyed by water, forming insoluble uranates.

Hydrochloric acid decomposes them with the evolution of chlorine; by the action of dilute nitric acid peruranic hydrate is formed, without any evolution of gas.

For the analysis of these compounds I made use of the method employed for the analysis of the yellow peruranates.

The uranium was estimated in the state of U_3O_8, the potassium in the state of chloroplatinate, and the water directly. To estimate the oxygen two methods are ap-

plicable. We can measure the volume of the gas resulting from the decomposition of the salt, and calculate it as uranic acid, UO_3. Or else, as has been recommended by Zimmermann (*Lieb. Ann. Ch.*, vol. ccxxxii., p. 273), reduce the salt by means of iodide of potassium and hydrochloric acid, and estimate the iodine set free by means of hyposulphite.

I prefer the former method, which is generally used in the analysis of peroxidised compounds.

The potassium salt answers to the formula $UO_3K_2.3H_2O$.

	Calculated.	Found.	
UO_3	63·72	63·58	63·70
O_2	7·08	6·87	6·95
K_2	17·25	17·33	17·35
$3H_2O$	11·95	12·00	12·11
	100·00		

The sodium salt has the composition $UO_3Na_2.5H_2O$.

	Calculated.	Found.	
UO_3	63·13	63·20	63·31
O_2	7·01	6·85	6·78
Na_2	10·08	10·12	10·30
$5H_2O$	19·75	20·10	20·04
	100·00		

Thus, there are two quite distinct classes of peruranates; the red peruranate that I have described, and which corresponds to the acid $UO_4.H_2O$, and the yellow salt, $UO_4(M_2O_2)_2$, discovered by Fairley.—*Bull. Soc. Chim.*, Series 3, vol. xxix., No. 8.

THE SEPARATION AND ESTIMATION OF ANTIMONY BY THE ELECTROLYTIC METHOD.

By A. HOLLARD.

The electrolytic estimation of antimony in solution in sulphydrate of sodium, which was described by Classen as being particularly suitable in the presence of tin and arsenic, since these elements are not deposited on the cathode with the antimony, is really open to certain objections pointed out already by Ost and Klapproth (*Zeit. f. Angew. Chem.*, 1900, p. 827), and by the present author (*Comptes Rendus*, 1896, vol. cxxiii., p. 1064; *Ann. de Chim. Analytique*, 1897, p. 242; *Bull. Soc. Chim.*, 1900, vol. xxiii., p. 291).

We will summarise these objections, and will describe a modification we have applied to Classen's method, which modification constitutes an excellent means of separation and estimation.

We have shown already that the use of concentrated sulphydrate of sodium, as described by Classen, offers serious difficulties; at the same time as the antimony, it dissolves appreciable quantities of copper (3 to 4 m.grms. per 100 c.c.), a metal which accompanies antimony very frequently; this copper is deposited on the cathode at the same time as the antimony.

We have got over this difficulty by transforming the copper into the state of complex cyanide ions, not susceptible of being deposited on the cathode; for this purpose it sufficed to add cyanide of potassium to the solution of sulphydrate of sodium.

On the other hand, Ost and Klapproth observed that the increasing amount of polysulphides formed round the anode during the course of the electrolysis, by the use of Classen's concentrated sulphydrate, passes by diffusion to the cathode, where it is able to dissolve the antimony already deposited. They proposed to arrest this diffusion by means of a diaphragm. The addition of cyanide of potassium to which we have just alluded prevents these difficulties occurring, and renders the use of a diaphragm superfluous.

The following is the method of procedure:—The antimony in the state of sulphide, or as oxide made slightly alkaline by the addition of soda, is dissolved in a mixture of 200 c.c. of saturated sulphydrate of sodium (density = 1·220 to 1·225), and 40 c.c. of an aqueous solution of cyanide of potassium at 20 per cent.

The electrodes are plunged completely into this solution, which occupies a volume of 240 c.c. These electrodes are the same as those we have already described (*Bull. Soc. Chim.*, 1900, vol. xxiii., p. 291), except that the truncated conical electrode which serves as the cathode is made of platinum gauze instead of platinum foil. The current should be about 0·1 ampère.

The presence of tin does not interfere with the reaction, provided there is not more than 1 grm. present.

Neither does the presence of copper matter, so long as there is not more than 0·05 grm. present. Further, it is always easy to keep below this proportion; it suffices to take up the compounds of copper and antimony by means of sulphydrate of sodium without cyanide, and to add the cyanide to the filtered sulphydrate solution.

The presence of arsenic does not interfere so long as it is in the state of arsenic acid, as shown by experiments 10, 11, and 12; further, Classen has pointed this out.

Preparation of the Concentrated Sulphydrate of Sodium.—The preparation of this reagent offers some difficulty; we shall therefore describe it in some detail.

A solution of soda is prepared of 1·3 density quite free from arsenic.* Five hundred c.c. are placed in a flask of at least 1·25 litres capacity, into which a wide tube is plunged. By means of this tube a strong current of sulphuretted hydrogen is passed through the soda, and this must not be stopped during the whole time of saturation; under these conditions the reaction is sufficiently lively to cause a slight disengagement of heat, which interferes with the crystallisation of the neutral sulphide of sodium, which is slightly soluble, and which would block up the tube if it was precipitated. The current of sulphuretted hydrogen is stopped when the level of the liquid, which rises continuously during saturation, rises no longer. At this point the remaining 500 c.c. of soda (density 1·3) are added to the sulphydrate formed; there is immediately an abundant crystalline precipitate of sulphide of sodium, which is re-dissolved with the help of a vigorous current of sulphuretted hydrogen, which must be kept up until the volume of the liquid no longer increases.

The solution of sulphydrate of sodium is transferred to a large porcelain crucible; it is boiled for twenty minutes, provided no crystalline skin is formed on the surface of the liquid before that time, in which case the flame must be withdrawn immediately.

The hot liquid is filtered through a double folded filter, which retains the insoluble impurities; it is then allowed to cool, and water is added to make the density 1·220 to 1·225.

The liquid should be kept away from the light in small flasks, well-filled, and tightly corked. In this manner the formation of polysulphides is prevented.

We can also prepare this sulphydrate of sodium by one single saturation instead of two; but in that case not more than 500 c.c. of soda must be used at a time, for fear of producing crystals of sulphide of sodium which would block up the tube. The saturation by sulphuretted hydrogen in two operations—which is also recommended by Classen—is more advantageous, as it enables us, in a relatively short time, to obtain large quantities of the sulphydrate.

* It is necessary, therefore, to guard against using soda-lime resulting from the preparation of sulphate of soda, as this salt is prepared by means of sulphuric acid generally very rich in arsenic. Alcoholic soda or even commercial ammoniacal soda-lye will do very well.

Experimental Results.

		Quantities weighed. Grm.	Sb deposited. Grm.
1.	Sb	0·1492	0·1504
2.	Sb	0·2000	0·2027
3.	Sb	0·1483	0·1543
4.	Sb	0·1500	0·1438
5.	Sb	0·4990	0·4990
	Sn	1·0000	—
6.	Sb	0·1473	0·1478
	Sn	0·3000	—
7.	Sb	0·1011	0·1008
	Sn	1·0000	—
	Cu	0·5000	—
8.	Sb	0·1490	0·1456
	Sn	0·1000	—
	Cu	0·0500	—
9.	Sb	0·2001	0·2024
	Sn	1·0000	—
	Cu	0·0500	—

Influence of Arsenic According to its Degree of Oxidation.

(As_V signifies :—Arsenic in the state of arsenic acid. As_{III} „ „ „ „ arsenious acid).

10.	Sb	0·0988	0·0982
	Cu	0·0500	—
	As_V	0·1000	—
11.	Sb	0·1489	0·1511
	Sn	1·0000	—
	Cu	0·0500	—
	As_V	0·1000	—
12.	Sb	0·1482	0·1561
	Sn	1·0000	—
	Cu	0·0500	—
	As_{III}	0·1000	—

In all these experiments the antimony, tin, and copper were attacked with nitric acid, evaporated to dryness, and the residue, made alkaline with soda, was taken up with the mixture of sulphydrate and cyanide. In experiment No. 7 only, the antimony, tin, and copper were in the form of sulphides.—*Bull. Soc. Chim.*, Series 3, vol. xxix., p. 262.

ON THE CONSTITUTION OF THE ELECTROLYTIC PEROXIDES OF LEAD, NICKEL, AND BISMUTH.

By A. HOLLARD

Lead.

It has always been admitted, up to the present time, that the peroxide of lead which is deposited on the anode in a saline solution of lead through which an electric current is passed, is the binoxide of lead, PbO_2, and the figure 0·866, which represents the proportion $\frac{Pb}{PbO_2}$ of the molecular weights of the lead and of the binoxide, has been given as the analytic factor for converting the weight of the peroxide deposited into the corresponding weight of lead. Contrary to this statement we have found:—(1) That the factor 0·866 is too high, and that besides PbO_2, superoxides more highly oxidised than PbO_2 are also deposited at the anode; (2) that the proportion of these superoxides is the greater as the concentration of the lead in the bath is less.

We have worked on a series of solutions of nitrate of lead (obtained from very pure lead from different sources), all of the same volume (300 c.c.), and all containing the same excess of nitric acid (12 c.c. of acid at 36°). The amounts of lead contained in these solutions varied in each case, from a few m.grms. up to 10 grms. The electrodes we used were made of platinum.

We have already described them (*Bull. Soc. Chim.*, vol. xxiii., p. 291) as far as their size and shape are concerned, but in the present instance the truncated conical electrode A, which serves as the anode, is made of platinum gauze instead of platinum foil. To obtain perfectly adherent and compact deposits on the anode, which is particularly difficult when dealing with large quantities of lead, we made use of a *platinised* platinum gauze,* and we added a large amount of nitrate of copper (equal to 10 grms. of copper) to the bath.†

This nitrate deposits only a portion of its copper on the cathode, while the whole of the lead is deposited on the anode in the state of peroxide. None of the deposits of peroxide were weighed until after having been washed,‡ and then dried in an oven heated gradually up to 200°.

In the following table we give the means of our results. Column I. gives the weight of lead present in the different baths; Column II. gives the corresponding analytic factors $\left(\frac{\text{weight of lead}}{\text{weight of peroxide}}\right)$:—

I.	II.	III.
0·0106	0·740	0·740
0·02	0·764	0·764
0·03	0·790	0·790
0·05	0·802	0·802
0·07	0·824	0·824
0·1	0·838	0·835
0·2	0·842	0·843
0·5	0·851	0·850
1·0	0·852	0·852
2·0	0·8545	0·8545
2·5	0·855	0·855
3·0	0·856	0·856
5·0	0·859	0·859
10·0	0·861	0·861

If we plot these results on a curve, taking the figures of Column I. as abscissæ, and those of Column II. as ordinates, it will be seen that at first the curve rises very rapidly up to a point corresponding to 0·1 grm. of lead; then it is inflected strongly but regularly to a point corresponding to 0·6 grm.; the remainder of the curve is almost a straight line, or at least of a very slight curvature, and it tends to reach the point 0·866 without, however, being able to attain it.

In column III. we have given the actual points through which the regular curve passes. It will be observed, if the curve be made, that it passes exactly through all the points found experimentally, with the exception of those corresponding to the abscissæ 0·1, 0·2, and 0·5 grm.

Interpretation of Results.—In the electrolysis of all these solutions the total quantity of oxygen carried to the anode during the whole course of the electrolysis is greater than that required for the exclusive formation of the binoxide, PbO_2. This excess of oxygen, which with high concentrations of lead is *nil*, or at least very slight at the commencement of the electrolysis, becomes considerable in the case of low concentrations; as a matter of fact, the proportion of oxygen is the same in all the solutions whether rich or poor in lead, and it remains constant during the whole course of the electrolysis. Thus we see how it is possible for higher oxides, more oxidised than PbO_2, to be formed, and how the proportion of these superoxides increases with the dilution.

The factors corresponding to the lowest concentrations show us that these superoxides are of a very high order.

* Platinum gauze has already a large surface. *Platinising* consists of covering the gauze electrolytically with a layer of platinum in a strongly acid (hydrochloric) bath, containing also oxalate of ammonia. In this manner we obtain a surface, the roughness of which is specially capable of retaining large quantities of peroxide of lead.

† The fortunate influence of nitrate of copper on the compactness of the peroxide of lead has been pointed out by Dandurand.

‡ To do this without detaching the electrodes, they were first plunged for an instant into a vessel of distilled water, then, *while still passing the current*, into a second vessel, also containing distilled water, for a quarter of an hour,

We are not able to say yet that we have to deal with only one highly oxidised superoxide, of which the proportion should increase gradually as the solution becomes more dilute, or whether we have to do with a series of superoxides, the more oxidised as they are formed at greater dilutions.

According to the preceding remarks, if we take a sufficiently concentrated solution of lead, there is no excess of oxygen at the commencement of the electrolysis, and a layer of PbO_2 is formed first; then, when the concentration has become diminished sufficiently, on account of the deposition of peroxide of lead at the anode, the oxygen, of which the concentration remains constant, is found to be in excess with regard to the lead; consequently, superoxides are formed in quantities that increase as the concentration of the lead diminishes.

This explanation is the one which appears to us to be the most reasonable, but it will be advisable to confirm it by control experiments. Two of these control experiments are immediately apparent:—

1. Make a deposit of peroxide in a solution kept at a high concentration, and see whether the deposit consists of pure PbO_2.

2. Make a deposit of peroxide in very dilute solution (a few m.grms. only of lead per 300 c.c.), keeping the concentration constant, until a thick layer of peroxide has been formed, and see whether this peroxide has the constitution of a superoxide as highly oxidised as that shown by the curve at a similar concentration.

But what remains, independently of this explanation, is the grave error that has been committed, up to the present, in electrolytic analysis by admitting that electrolytic peroxide of lead is PbO_2, and that the factor is 0·866. The curve and the tables will enable us in the future to obtain factors corresponding to a large number of concentrations of lead.

Nickel.

Lead is not the only metal which forms superoxides of a high order by electrolysis. Nickel, in alkaline solution of pyrophosphate treated with chromic acid, gave a peroxide—with a concentration of 0·05 grm. of nickel per 300 c.c., the bath being at a temperature of 70°—which, dried at 120°, corresponded to the constitution NiO_4, and which did not vary in weight when heated as high as from 120° to 170°. The current, which was of 0·1 ampère, was passed through the bath for fifty-four hours.*

This peroxide is very difficult to obtain. The most highly oxidised oxide of nickel yet known answers to the formula Ni_2O_3.

Bismuth.

Bismuth gave a deposit at the anode which, when dried at 130°, corresponded to the formula Bi_2O_7 in a concentration of 0·05 grm. of bismuth per 300 c.c. of bath.

The bismuth was in the form of sulphate, in the presence of 20 c.c. of nitric acid at 36° in excess, and 40 grms. of hydrated sulphate of copper for a volume of 350 c.c. of bath. The deposit of peroxide of bismuth—of which the constitution Bi_2O_7 was given by a large number of experiments—is of a citron-yellow colour, and does not vary in weight when heated up to 180°.

The most highly oxidised oxide of bismuth yet known has the constitution Bi_2O_5.

We have not tried whether the constitution of the peroxides of nickel and of bismuth varies with the concentration of these metals. Besides, we have not been able to deposit quantities corresponding to more than 0·05 grm. of metal, which necessarily limits this examination.

Other Metals.

We have not examined the electrolytic peroxides of silver and manganese, which are the only electrolytic peroxides known, besides those we have just dealt with.

If other metals do not give electrolytic peroxides, this is apparently due to the fact that their peroxides are non-conductors of electricity.*

However, these peroxides can be obtained by depositing them with conducting peroxides. In this manner we succeeded in depositing with peroxide of lead, peroxides of antimony and of arsenic, and with manganese a peroxide of iron.† But what is the degree of oxidation of these peroxides we have not yet been able to determine. —*Bull. Soc. Chim.*, Series 3, vol. xxix., No. 4.

THE USE OF A ROTATING CATHODE IN THE ELECTROLYTIC DETERMINATION OF THE METALS.‡

By F. A. GOOCH and H. E. MEDWAY.

THE rotating cathode has been applied usefully in the arts for the purpose of securing compact metallic deposits in electro-plating. In this case a soluble anode is employed, and the electromotive force of the current is generally low. So far as we are aware, however, no attempts have been made heretofore to apply the rotating cathode in analytical separations, in which it is the object to remove the metal completely from solution. In such processes the soluble anode is not used, and the comparatively high electromotive force necessary to overcome the resistances and to throw down the metal with rapidity liberates hydrogen from the water solution simultaneously with the metal, and the consequence is the production of a deposit lacking in compactness and adhesiveness. This interference on the part of the evolved hydrogen with the regularity of deposition appears to be the chief reason why low intensity and low density of current must be used in the ordinary electrolytic processes of analysis. We have made some experiments, therefore, to see whether it is not possible to so far avoid the interfering action of hydrogen by the use of the revolving cathode, as to secure with high currents and in a short time deposits sufficiently adherent and homogeneous for analytical purposes. The results, as will appear, are successful.

For a cathode we have used an ordinary 20 c.m.³ platinum crucible rotating at a speed of from 600 to 800 revolutions a minute. The crucible is driven by a small, inexpensive electric motor fastened so that its shaft is vertical. Upon this shaft the crucible is fixed by pressing it over a rubber stopper bored centrally and fitted tightly on the end of the shaft (Fig., A). To secure electrical connection between crucible and shaft, a narrow strip of sheet platinum is soldered to the shaft and then bent upward along the sides of the stopper, thus putting the shaft in contact with the inside of the crucible when the last is pressed over the stopper. The shaft is made in two parts as a matter of convenience in removing the crucible, and is joined, with care to make a good contact between the two pieces of shafting, by a rubber connector of sufficient thickness to prevent the crucible from wobbling when rotated.

The solution to be electrolysed is placed in a beaker upon a small adjustable stand, so that the crucible may be dipped into the liquid to any desired depth. A platinum plate is employed as an anode, and this is connected to the positive pole of a series of four storage batteries, while the negative pole of this series is connected to the bearing in which the shaft rotates, thus allowing the current to

* We omitted to try whether there was any nickel left in the bath at the end of this time. If there was any, the peroxide deposited corresponded to a degree of oxidation higher than NiO_4.

* In this case the system of electrodes used was that of Luckow (*Comptes Rendus*, vol. cxxiii., p. 23); the cone which served as the anode became, through prolonged usage and repeated calcinations, of a roughness which was preferable to that of recently platinised platinum.

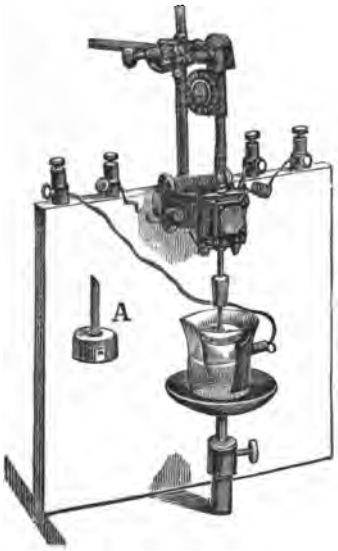
† The carrying down of iron with peroxide of manganese has been observed already by Neumann ("Analytische Elektrolyse," p. 194).

‡ Contributions from the Kent Chemical Laboratory of Yale University. From the *American Journal of Science*, xv., p. 329.

go from the platinum plate through the solution to the crucible, up the shaft of the motor and back to the batteries.

The power to run the motor is taken from the incandescent light circuit of the street.

The first attempts were made with the deposition of copper from a solution of the sulphate, and the procedure was as follows:—The solution, 50 c.m.³ in volume, was placed in a 150 c.m.³ beaker and acidulated to give better conductivity. The stand carrying the beaker was raised until the liquid covered about two-thirds of the crucible adjusted to the shaft, thus giving a cathode surface of about 30 c.m.². The anode was introduced and the motor started. The wires from the storage batteries were connected, and the current allowed to pass through the solution. The duration of the electrolysis was varied according to the strength of current used, but in each case, after the deposit was nearly complete, the current from the batteries was shut off, the motor stopped, and the sides of the beaker, the platinum anode, and the crucible were carefully washed with a fine jet of water, the motor was again started, and the current allowed to pass for the remaining time.



When the deposit was complete the crucible was removed and washed, first with water, then with alcohol, and finally was dried by passing it over a flame.

Sulphuric acid (6 or 7 drops of the dilute acid, 1 : 4) was generally used to acidulate the solution, since it was found that the copper was deposited in a shorter time with sulphuric than with nitric acid present. A few experiments were made in which small amounts of nitric acid were used to show that the copper could also be deposited completely in presence of this acid.

Table A shows the results of a series of experiments made as described above in solutions acidulated with sulphuric acid. The standard of the solution of copper sulphate was fixed by the usual slow method of electrolytic analysis.

That the copper can be completely deposited, though more slowly, from a solution acidulated with nitric acid, is shown in Tables B and C. In the experiments of Table B the solution contained 6 drops of dilute (1 : 4) nitric acid, and in those of Table C 9 drops.

The rapid deposition of silver was next tried. To a 50 c.m.³ solution of $AgNO_3$ was added enough potassium cyanide to dissolve the AgCN first formed. Three c.m.³ of dilute sulphuric acid were run in, and enough ammonia to make the solution strongly alkaline. The method of manipulation was exactly the same as in the case of copper.

TABLE A.

	Copper taken. Grm.	Copper found. Grm.	Error. Grm.	Curtent. Ampères.	$N.D_{100}$.	Time. Minutes.
1.	0·0651	0·0652	+0·0001	0·8	2·7	25
2.	0·0651	0·0652	+0·0001	0·8	2·7	15
3.	0·0651	0·0651	0·0000	1	3·3	10
4.	0·0651	0·0649	−0·0002	1	3·3	10
5.	0·0651	0·0648	−0·0003	1	3·3	10
6.	0·1272	0·1272	0·0000	2·5	8·3	15
7.	0·1272	0·1271	−0·0001	2·5	8·3	15
8.	0·1272	0·1271	−0·0001	2·5	8·3	15
9.	0·1272	0·1270	−0·0002	3	10	13
10.	0·1272	0·1268	−0·0004	3	10	12
11.	0·2548	0·2548	0·0000	3	10	20
12.	0·2548	0·2548	0·0000	4	13·3	20
13.	0·2548	0·2550	+0·0002	4	13·3	20
14.	0·2548	0·2546	−0·0002	4	13·3	15
15.	0·2548	0·2545	−0·0003	4	13·3	15

TABLE B.

Copper taken. Grm.	Copper found. Grm.	Error. Grm.	Current. Ampères.	$N.D_{100}$.	Time. Minutes.
0·0651	0·0648	−0·0003	1	3·3	35
0·0651	0·0652	+0·0001	0·8	2·7	30
0·0651	0·0650	−0·0001	0·8	2·7	25
0·0651	0·0649	−0·0002	1	3·3	25
0·0651	0·0650	−0·0001	0·8	2·7	25

TABLE C.

Copper taken. Grm.	Copper found. Grm.	Error. Grm.	Current. Ampères.	$N.D_{100}$	Time. Minutes.
0·0651	0·0652	+0·0001	1	3·3	35
0·0651	0·0648	−0·0003	1	3·3	30
0·0651	0·0650	−0·0001	1·5	5	25
0·0651	0·0650	−0·0001	1·5	5	25
0·0651	0·0647	−0·0004	1·8	6	20

Table D records the determinations made with a solution of silver nitrate standardised as the chloride.

TABLE D.

	Silver taken. Grm.	Silver found. Grm.	Error. Grm.	Current. Ampères.	$N.D_{100}$.	Time. Minutes.
1.	0·0968	0·0966	−0·0002	1·8	6	15
2.	0·0968	0·0967	−0·0001	1·9	6·3	15
3.	0·0968	0·0965	−0·0003	1·8	6	15
4.	0·0968	0·0969	+0·0001	2	6·7	10
5.	0·0968	0·0965	−0·0003	3	10	8
6.	0·1898	0·1901	+0·0003	2·5	8·3	10
7.	0·1898	0·1898	±0·0000	2·5	8·3	10
8.	0·1898	0·1900	+0·0002	3·	10	10
9.	0·1898	0·1893	−0·0005	2·5	8·3	10

The rapid deposition of nickel was equally successful. Nickel-ammonium sulphate was dissolved in 25 c.m.³ of water and 20 c.m.³ of strong ammonia were added. In this liquid about a grm. of ammonium sulphate was dissolved, and the solution was treated in the same manner as in the preceding experiments upon copper and silver. It should be especially noted, however, that the solution must be kept within the limits of volume indicated above, as further dilution lengthens the time necessary for complete deposition.

From the results in Table E it is plain that nickel, like copper and silver, may be deposited with rapidity and completeness.

The metallic deposits of these metals obtained by means of the revolving cathode are sufficiently coherent and compact to permit accurate manipulation and weighing, even when the current density on the cathode is very con-

siderable and variable within wide limits. Other metals have been found to behave similarly, and the results of further experimentation will be described later.

TABLE E.

	Nickel taken. Grm.	Nickel found. Grm.	Error. Grm.	Current. Ampères.	N.D.$_{100}$.	Time. Minutes.
1.	0·0954	0·0954	0·0000	1·5	5	30
2.	0·0954	0·0953	−0·0001	3	10	25
3.	0·0954	0·0956	+0·0002	3	10	25
4.	0·0954	0·0953	−0·0001	3·5	11·7	20
5.	0·0954	0·0955	+0·0001	3·5	11·7	20
6.	0·1738	0·1736	−0·0002	3·5	11·7	25
7.	0·1738	0·1740	+0·0002	3·5	11·7	25
8.	0·1738	0·1740	+0·0002	4	13·3	25
9.	0·1738	0·1737	−0·0001	4	13·3	25
10.	0·1738	0·1738	0·0000	4	13·3	25

The advantages of this rotating cathode in analytical operation are obvious; the process as described is rapid, exact, and very simple. The apparatus required, moreover, is inexpensive, and, if it is desired to make many determinations simultaneously, a single motor may be made to drive a running belt over any reasonable number of rotating shafts.

NOTICES OF BOOKS.

Practical Chemistry; a Laboratory Course for Secondary Day Schools and Evening Classes. By WALTER HARRIS, M.A., Ph.D. In Three Volumes. London: Whittaker and Co. 1903. Pp. 410.

A HANDBOOK such as this will be useful alike to the teacher and the student, to the former by relieving him to some extent of a wearying number of questions, and to the latter by teaching him to help himself. The book is published in three separate volumes, which are devoted to:—(1) Measurement, (2) Exercises and Problems, and (3) Qualitative and Quantitative Analysis.

Accurate measurement is one of, if not the most important operations in chemistry, and the author has wisely put it in the first place, as students cannot be taught too soon the necessity for correct weighing and measuring. Density, specific gravity, volumetric measurements, &c., all come under this heading, and are dealt with in the first volume. Volume II. is more theoretical in its tone, and deals with the properties of the elements in regard to their mixing and combining with other elements, and the various phenomena which occur when chemical reactions take place.

Volume III., on Qualitative and Quantitative Analysis, takes the student through the routine work of detecting and recognising the various elements and salts, either alone or in mixtures, by means of their reactions and behaviour with reagents.

A careful student should obtain a very good elementary knowledge of chemistry by the help of this book.

Chemical Novelties for 1903. ("Les Nouveautés Chimiques pour 1903"). By CAMILLE POULENC, Dr. es Sc. With 186 Figures in the Text. Paris: J. B. Baillière et fils. 1903. Pp. 326.

THIS book will be very useful to chemists, as the author has dealt with all the latest laboratory apparatus and new methods of research, as applied to science and the arts, in a methodical manner.

In the first chapter we find full descriptions of new physical apparatus as applied to chemistry, such as apparatus for the determination of densities, of high temperatures, fusing-points, &c.

Chapter II. comprises new apparatus for chemical manipulation, gas-burners, ovens, temperature regulators, extraction apparatus, and new methods of producing gases, &c.

Chapter III. deals with chemical apparatus in the use of which electricity is employed, such as regulators, transformers, interruptors, voltmeters, &c. The introduction of electricity, by the electrolytic phenomena it brings about, as well as by its thermal action, has carried chemistry along a new and prolific path, and at the same time has been the cause of the introduction of new methods into laboratories; it has given us fresh means of investigation of a high value. By its use we have now at our command the means of obtaining the highest temperatures with the greatest rapidity, combined with exact and simple regulation.

Chapter IV. is devoted to chemical analysis in general, with special sections for gas analysis, metallurgical assaying, technical analysis, and special apparatus for the examination of foods and drugs.

Chapter V. and last deals with the new and interesting apparatus introduced for the study and application of bacteriology. Among these we may mention an ingenious method for taking samples of water for chemical and bacteriological examination at one and the same time, while preventing the possibility of any external contamination of the sample.

The book contains a complete table of contents and a good index.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

NOTE.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 19, May 11, 1903.

Researches on the Law of Electromotive Forces developed by Reciprocal Actions of Saline Solutions.—M. Berthelot.—The author examines the relation existing between the electromotive force developed by the action of an acid on a base (E) and the forces developed by the action of the corresponding salt, firstly, on the acid (E_1), and then on the base (E_2). He establishes, by exact measurements on electrodes incapable of polarisation, the law that $E = E_1 + E_2$. The experiments were all performed with dilute solutions containing the equivalent weight of each body dissolved in the same volume of water. Six acids and two bases were used in the research.

Electrolysis of Alkaline Sulphides.—André Brochet and Georges Ranson.—When electrolysing a concentrated solution of sulphide, the authors find that, at a given moment, the needle of the voltmeter and that of the ammeter oscillate in a regular manner. The amplitude of the oscillations is greater according as the density of the current is increased; this phenomenon is due to the deposition and to the successive solution of a thin layer of sulphur on the anode. In all the series of experiments, with or without a diaphragm, potassium sulphide behaves exactly as sodium sulphide. In fact, the electrolysis of an alkaline sulphide gives, according to the conditions of concentration, either sulphur or compounds due to its oxidation, the final one being sulphuric acid.

Benzene-azo-orthobenzylic Alcohol and its Transformation into Phenyl-indazol and Azodiphenylmethane.—P. Freundler.—The author obtains benzene-orthoazobenzylic alcohol by the condensation of nitrobenzene with ortho-aminobenzylic alcohol in presence of alcohol and acetic acid. This substance possesses the singular property of dehydrating with the greatest ease under various influences. When heated to about 80° with a 50 per

cent sulphuric acid solution, it is quantitatively transformed into phenyl indazol. This phenyl indazol is also produced when benzene-azo-benzylic alcohol is heated above 130° *in vacuo* or at ordinary pressure, but in this latter case it is accompanied by a certain quantity of an isomeric compound which can only be azodiphenylmethane.

Organo-metallic Derivatives of Di-halogen Aromatic Hydrocarbons. Action of Iodine.—F. Bodroux.—Di-halogen aromatic hydrocarbons form poly-substituted bodies capable of forming compounds with magnesium in presence of ether. The author thus transforms—Dibromobenzene-1.4 into parabromoiodobenzene, dibromobenzene-1.3 into metabromoiodobenzene, bromochlorobenzene-1.4 into parachloroiodobenzene, and dibromonaphthalene-1.4 into bromoiodonaphthalene.

Methylation of Ethylglutaconate.—E. E. Blaise.—The author continues a previous research on the methylation of ethylglutaconate at 0°. He now conducts his researches at higher temperatures, and succeeds in introducing a third methyl group into the molecule of glutaconic acid.

Migration of the Methyl Group in the Molecule of Camphor.—G. Blanc and M. Desfontaines.—This paper describes a continuation of a former research on the structural change in the camphor molecule.

Successive Action of Acids and Soluble Ferments on Polysaccharides of High Molecular Weight.—Em. Bourquelot and H. Hérissey.—The authors establish the fact that the polysaccharides which are more condensed than gentianose can only be hydrolysed by the action of certain ferments.

Diastasic Decomposition of Salol.—E. Pozzi-Escot.—The author finds that the saponifying ferments of vegetable grains, which are very active towards the ether functions of the acyclic fatty acids, have scarcely any action towards the phenolic ether functions. In other cases he utilises free phenol as an antiseptic agent without sensibly destroying the saponifying action of vegetable lipases. There can, however, from all the experiments performed, be no question as to the destructive influence of the phenol resulting from the saponification of salol.

MISCELLANEOUS.

Royal Institution.—A General Monthly Meeting of the Members of the Royal Institution was held on the 8th inst., Sir James Crichton-Browne, Treasurer and Vice-President, in the Chair. Sir Walter J. Sendall, G.C.M.G., was elected a Member.

Change of Address.—Mr. Bertram Blount, consequent on the death of his partner, has removed to 76-78, York Street, Westminster, where he will continue in practice under his own name.

The Faraday Society.—The Council of this Society begs to draw the attention of members to the following arrangements that have been made:—(1) The Proceedings of the Society will be published in *The Electro-Chemist and Metallurgist*," which will be published monthly, free to members. (2) All papers presented to the Society will be printed and circulated among the members before being read, and, as a rule, they will be read in abstract only. Members and others unable to be present will be asked to send their contributions to the discussion in writing, and their remarks will be read out to the meeting. By this means it is hoped greatly to increase the value of the discussions, and to give absent members an opportunity of expressing their views.

The Dinitration of Hydrazine.—M. Betti.—When we wish to effect the dinitration of hydrazine, we always obtain the azoimide through the action of the H_2N- on the oxide of azonium which is formed first, on the other $NH_2 : H_2N-N=NOH=H_2O+N_3H$. However, we can obtain a chain of 4N by reacting with hydrazine on nitroso-acetylacetic ether. For this purpose we use a solution of sulphate of hydrazine, which is made to react on a solution of 2 molecules of nitroso-ether. After seven hours' contact we obtain a product of condensation in the form of canary-yellow needles, insoluble in water, but soluble in alcohol, from which it crystallises in flakes or in cubes, fusible at 197°. The most probable formula is—

$$\begin{matrix}CH_3-CO\\C_2H_5-O_2C\end{matrix}\!\!>\!CH-N=N-N=N-CH\!<\!\begin{matrix}COCH_3\\CO_2C_2H_5\end{matrix}.$$

The Na_2 salt is crystalline, and forms a citron-yellow solution in water. It deflagrates with heat, and precipitates the salts of the heavy metals.—*Gazz. Chim. Ital.*, vol. xxxii., [II.], p. 146.

The Composition of Rapidly Setting Cements.—O. Rebuffat.—Commercial quick setting cements are all natural products. If we try to make artificial cements we observe that the mixture of kaolin or clay, with lime or crystalline carbonate of lime, does not give a coherent cement; on the other hand, we obtain a cement which sets very rapidly if we use amorphous $CaCO_3$, prepared by precipitating $CaCl_2$ by Am_2CO_3 in the cold. Further, it is very remarkable that lime prepared from crystalline $CaCO_3$ becomes hydrated very rapidly, while that prepared from amorphous $CaCO_3$ is quite porcelainic, and does not react with water. A mixture of $2SiO_2$, $2Al_2O_3$, and $5CaO$, burnt, and then submitted to the action of water, does not give a very coherent cement, although its formula corresponds to that of a good one. The temperature of baking a rapid setting cement should be from 700 to 800°; at 1100° to 1300° it becomes much slower, and then loses its property of setting. The best proportion to use is $2(SiO_2,Al_2O_3)6CaO$. It is not necessary for a rapid setting cement to contain free SiO_2. *The Chemical Properties of Artificial Kaolin Cements.*—For the burning to have taken place between 800° and 1200° the amount of CaO soluble in syrup should offer but slight variations. After hydration the amount of lime soluble in syrup is different to that of the anhydrous product; thus water plays another part besides that of hydration. By burning a mixture of $2SiO_2,2CaO+Al_2O_3,2CaO$ at 800°, we obtain a product that swells up considerably in water without setting; by baking for eight days, it gives, on the other hand, a cement setting very rapidly.—*Gazz. Chim. Ital.*, vol. xxxii., [II.], p. 254.

The Periodates of Lead and Copper.—F. Giolitti.—$Pb.HIO_3$.—A solution of acetate of lead acidulated with acetic acid, gives a white precipitate with dipotassic iodate, K_2HIO_5. When dried it turns slightly yellow, and becomes crystalline. At 140° it loses water, and changes to $Pb_2I_2O_9$, an orange-yellow powder insoluble in water. In two experiments, and without the author having been able to determine the difference of the conditions, a yellow precipitate of $Pb_5I_2O_{10}\,2H_2O$ was obtained instead of $PbHIO_5$. On the other hand, freshly precipitated $PbHIO_5$ gives, on boiling with acetate of lead, an orange-yellow powder of $Pb_5I_2O_{10}$. $PbHIO_5.H_2O$.—This salt is obtained by precipitating acetate of lead by an aqueous solution of periodic acid; it is a white powder, losing H_2O at 110°. Pb_2HIO_6.—$PbHIO_5$ submitted to prolonged boiling in water, gives this salt in the form of a brown crystalline powder. $Pb_3I_2O_{10}H_2O$.—A solution of $PbHIO_5$ in nitric acid is treated with the freshly precipitated hydrated lead; it is a white crystalline powder. *Periodates of Copper.*—$CuHIO_6$ is a green powder obtained by precipitating a solution of acetate of copper by K_2HIO_5; it loses water at 120°, and forms the salt $Cu_4I_2O_{11}$, which is a brown powder. $Cu(IO_4)_2$.—A sky-blue precipitate obtained by boiling acetate of copper with periodic acid. $Cu_5I_2O_{12}.7H_2O$ is a dark green precipitate obtained by boiling the precipitate formed by K_2HIO_5 and a large excess of acetate of copper, in ammonia. The hydrate, $Cu_5I_2O_{12}.3H_2O$, is obtained in the form of a yellowish

green powder by dissolving Cu_5HIO_6 in nitric acid, then adding hydrated oxide of copper, and boiling the solution. —*Gazz. Chim. Ital.*, vol. xxxii., [II.], p. 340.

Catalytic Oxidation of the Alcohols (the Case of the Platinum Spiral).—A. Trillat.—In summing up the most interesting points in the catalytic action of platinum, and of porous bodies in general, on the alcohols, the author observes that the primary alcohols gave the corresponding aldehydes; the secondary alcohols, a ketone; while the tertiary alcohols gave principally the ketone immediately below formic aldehyde. Contrary to the opinion of several chemists, water is not an obstacle to the chemical phenomena due to contact action. The temperature at which oxidation by contact with the platinum spiral commences to take place is lower than 200°. In most of the cases examined, the heat given off by the oxidation of the alcohols, or by their molecular disaggregation, is capable of maintaining the platinum spiral in an incandescent state. By oxidation with platinum black, the action is less limited, and approaches that of chemical agents. In such cases, acids and ethers were obtained frequently, instead of aldehydes. The mechanism of oxidation observed is as follows:—In the case of a moderate oxidation the action is limited strictly to the formation of the corresponding aldehyde with a more or less considerable proportion of acetal; at least this is so for the first terms of the alcohols of the fatty series. A more energetic oxidation (white heat with excess of oxygen) has the effect of transforming the aldehyde into the corresponding acid, which is itself easily dissociated. As secondary products, the formation of ether resulting from the combination of the acid with the alcohol has been observed.—*Bull. Soc. Chim. de Paris*, xxix., No. 1.

MEETINGS FOR THE WEEK.

WEDNESDAY, 17th.—Microscopical, 8. "On the Theory of Optical Images, with special reference to the Microscope," by the Rt. Hon. Lord Rayleigh, F.R.S. "On a Method of making Visible Ultra-microscopic Particles in Glass, and the Application of the Method to Bacteria," by Dr. H. Siedentopf. "On the Lag in Microscopic Vision," by E. M. Nelson.

— Chemical, 5. "The Estimation of Arsenic in Fuel" and "The Electrolytic Estimation of Minute Quantities of Arsenic, more especially in Brewing Materials," by T. E. Thorpe. "Crystallised Ammonium Sulphate, and the Position of Ammonium in the Alkali Series," by A. E. H. Tutton. "Action of Hydrogen on Sodium," by A. Holt, jun. "The Action of Halogens on Compounds containing the Carbonyl Group" and "Reactions involving the Addition of Hydrogen Cyanide to Carbon Compounds," by A. Lapworth. "The Aceto-acetic Ester Synthesis," by A. C. O. Hann and A. Lapworth. "Rimu Resin" and "Note on the Karaka Fruit," by T. H. Easterfield and B. C. Aston.

FRIDAY, 19th.—Royal Institution, 9. "Radium" (in French), by Prof. Pierre Curie.

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Re Pirie *v.* The Company and Others.—The Electro-Chemical Co. (1900), Ltd., 1901, E. 85.—By orders of Mr. Justice Farwell.

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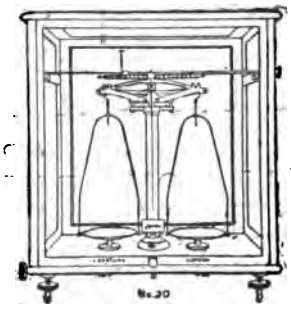

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VOL. LXXXVII., No. 2273.

THE DETERMINATION OF CARBON IN STEEL BY DIRECT COMBUSTION IN OXYGEN.

By LAWRENCE DUFTY.

THE simplest method that has been suggested for the determination of carbon in steel is undoubtedly the direct combustion of the sample in oxygen. But although this method was used for pig-iron as far back as 1862 by Mulder (CHEMICAL NEWS, vol. v., p. 5), and later for steel by Herman with good results (CHEMICAL NEWS, vol., xl., p. 263), the opinion generally prevalent appears to have been that the process was uncertain and the results low. Within the last few years, however, Rozyetti (*Journ. Soc. Chem. Ind.*, 1899) and Blount (*Analyst*, 1902) have shown that the method is reliable if necessary conditions are adhered to.

As a result, the process—more or less modified—seems to be gradually coming into favour, and not without good reason, for if the essential condition be strictly observed, viz., that the drillings used be sufficiently thin, the process gives perfectly accurate results, and a carbon determination can be made in the remarkably short time of forty minutes or less from time of receipt of sample. Thin curly drillings may be simply placed in a boat and burnt in oxygen without any reagent. As a general rule, however, especially if the drillings are very small or inclined to be powdery, it is necessary to mix with some material which will separate the particles and, if possible, assist in the oxidation of the sample without fusing to a liquid mass, as is the case when using the oxides of lead or bismuth, as recommended by Brearley (CHEMICAL NEWS, vol. lxxxiv., p. 23), and Leffler (CHEMICAL NEWS, vol. lxxxv., p. 121). Rozyetti used Al_2O_3, Rhead and Sexton ("Assaying and Metallurgical Analysis") suggest MgO, whilst Brearley and Ibbotson ("Analysis of Steel Works Materials") find ZnO satisfactory for certain alloys; other oxides suggested are SiO_2, CaO, SnO_2 Mn_3O_4, &c.

In order to ascertain if any one oxide had an advantage over another, a series of combustions were done with steels mixed with Al_2O_3, ZnO, MgO, CaO, $S O_2$, Mn_3O_4 and SnO_2 respectively. All gave almost identical results, and all remained "dry" (and mostly uncombined), except CaO, which forms with the oxide of iron a slag just fusible at the usual temperature of the furnace used.

As the advantage, if any, seemed to be with MgO, Al_2O_3, and CaO, the first of these was chosen, and the direct process thoroughly tested, using this oxide throughout. The method adopted was as follows:—

2·727 grms. of drillings (not exceeding 0·5 m.m. in thickness for hard, and 0·25 m.m. for mild steels), or 1·3636 grms. of pig-iron (grey pig is powdered until it all passes through a sieve 40 meshes to the inch), are mixed with ½ grm. of freshly ignited MgO by shaking in a weighing bottle, and then transferring to a boat containing a layer of MgO—a further portion of the oxide being spread over the top to cover any drillings exposed. (If the magnesia gives any "blank," a definite quantity must always be used and the blank deducted). Having placed the boat in the red-hot tube, the aspirator is set working, and at the end of a few minutes—sufficient time being given for the boat to attain a red heat—the oxygen is turned on, and, as soon as the steel begins to burn, is allowed to enter at a decidedly rapid rate. At this stage very little gas passes through the KOH absorption bulb, practically all the oxygen combining with the steel. When the gas bubbles through the absorption bulb at about the same rate as that at which it enters the furnace, the oxygen is turned off (the combustion of the sample being complete), and about a litre of air is passed through, the absorption bulb being then detached and weighed. The increase in weight, minus the blank, multiplied by 10 or 20, according to the weight taken, converts the CO_2 to carbon per cent.

The results obtained from a series of standard steels by the above method are compared in the following table with those obtained by solution in copper-ammonium chloride and combustion of the dried carbonaceous residue.

	Sample.	Carbon, per cent. Ordinary solution method.	Direct with MgO and O.
1.	Steel	0·22	0·22, 0·23
2.	,, ...	0·29	0·30, 0·30
3.	,, ...	0·48	0·48, 0·49
4.	,, ...	0·62	0·63, 0·62
5.	,, ...	0·87	0·87, 0·88
6.	,, ...	1·07	1·09, 1·08
7.	,, ...	1·20	1·22, 1·22
8.	,, ...	1·45	1·47, 1·47
9	,, ...	2·29	2·32, 2·29
10.	,, ...	2·47	2·50, 2·53
11.	White pig	3·57	3·60
12.	,, ...	3·82	3·84
13.	Grey pig	4·04	4·05
14.	,, ...	4·12	4·12
15.	,, ...	4·36	4·32

In dealing with special steels and alloys, the solution method is always more or less troublesome when tungsten or molybdenum is present in any quantity, and the results are generally unsatisfactory, often decidedly so. For such steels a direct method is really the only way by which the full carbon contents can be ascertained.

By the process given above, special steels and alloys, when in the form of drillings, give up the whole of their carbon almost as readily as ordinary steels. It is essential, however, when chromium is present to any appreciable extent, that the drillings do not exceed ½ m.m. in thickness. (With a little experience this can be judged by the eye). In the following table it will be noticed how consistently low are the results obtained by the ordinary combustion process, when compared with the direct, for samples containing large amounts of chromium and tungsten or molybdenum.

	Special contents, per cent.	Carbon, per cent. Ordinary solution method.	Direct, with MgO and O.
16.	Ni .. 3·8	0·34	0·36
17.	Ni .. 23·0	0·79	0·82
18.	Cr .. 1·0	0·88	0·90
19.	Cr .. 4·7 Si .. 2·5	1·76	1·79
20.	Mo .. 4·1	0·77	0·88
21.	Mo .. 5·1 Cr .. 4·0	0·64	0·84
22.	W .. 2·8	1·24	1·27
23.	W .. 4·8	0·55	0·59
24.	W .. 9·1 Cr .. 5·1	0·44	0·51
25.	W .. 11·0 Cr .. 6·5	0·36	0·42
26.	W .. 20·2 Cr .. 4·7	0·59	0·67
27.	W .. 21·5 Cr .. 7·0	0·90	Direct, with Pb_3O_4. 0·92
28.	W .. 32·0 Cr .. 10·0	1·60	1·61

In most of the foregoing combustions, and in many others, the drillings used were as usually supplied to the laboratory—no special drilling being found to be necessary, except in the case of mild and a few special steels.

Alloys which will not drill after careful annealing, if

powdered and ground to a fine state of division in the agate mortar and then well shaken with MgO or CaO, will, in the majority of cases, burn completely in oxygen. Some ferro-chromes, even, will oxidise if thoroughly "floured" in the mortar and ignited for a sufficient length of time.*

A few results of some manganese alloys, which generally have their carbon percentage determined by the solution method, are given as illustrating the higher, and no doubt correct, results obtained by the direct magnesia process.

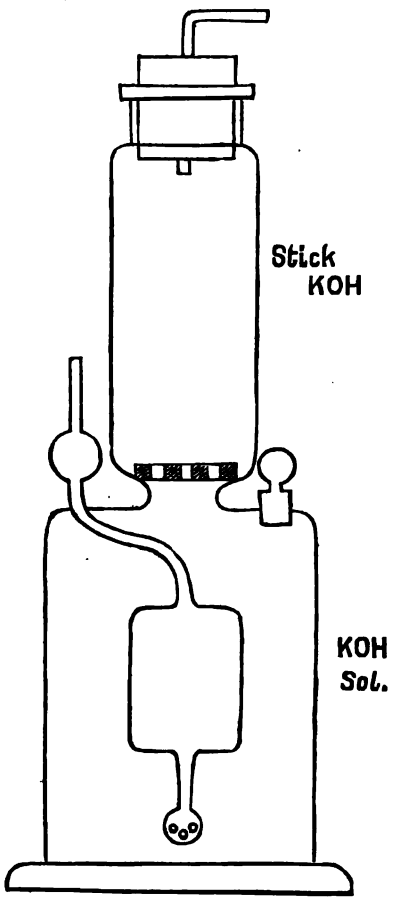

FIG. 1.

	Carbon, per cent.	
	Ordinary solution method.	Direct, with MgO and O.
29. Ferro-manganese (80 per cent)	6·69	6·88
30. Do.	6·55	6·70
31. Do.	6·88	7·05
32. Spiegel (20 per cent) ..	4·69	4·87
33. " " ..	5·96	6·06
34. Silico-spiegel	1·89 / 1·90 Oxygen alone.	2·14 / 2·16

Although silico-spiegels, as a rule, burn completely in oxygen without any reagent, the results of the sample quoted above shows the advisability of always using an oxide with these alloys.

* For these very refractory alloys, however, the use of Bi_2O_5 or Pb_3O_4, as recommended by Brearley (CHEMICAL NEWS, vol. lxxxiv., p. 23), is to be preferred as being quicker and more certain of giving the full carbon contents.

From what has been stated it will be apparent that the direct combustion process is not only an alternative to the usual solution method, strongly appealing to the steel-works chemist on account of its reliability, simplicity, and speed, but, as shown, such a direct method is absolutely essential in the case of most special steels and some alloys, if an accurate determination of the carbon is to be made.

A few notes on the process, and details of the apparatus used, may be of service.

When a combustion is finished, the boat is withdrawn, its contents turned out by means of a piece of wire or the tang of an old file, and then re-charged with the next sample. The oxidised drillings should always frit together in the form of a long cake, which is very easily extracted owing to the boat being protected by the unfused magnesia.

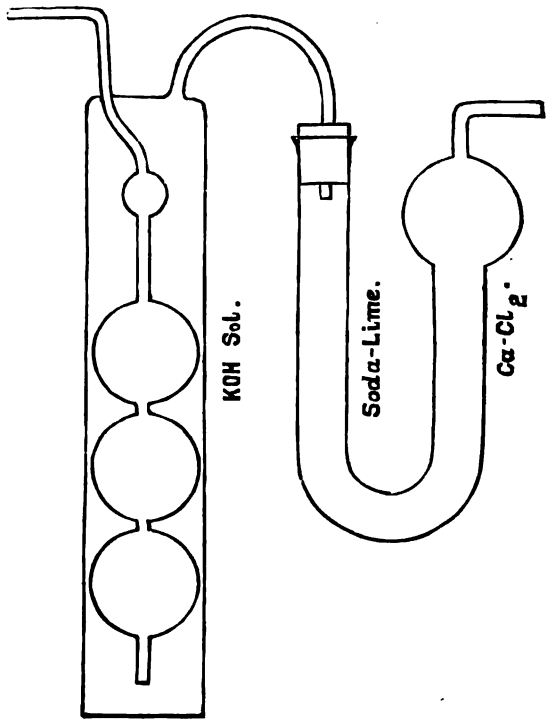

FIG. 2.

If the steel should not have been completely burnt, the drillings will be detached from each other—no fritting whatever having taken place. In this case either thinner drillings are required, or more heat should be applied.

Both MgO and CaO require igniting at a high temperature in the muffle to completely drive off CO_2, and, in the case of lime that has been prepared from marble, it is advisable to do a blank of each batch after ignition. As these oxides, however, absorb CO_2 from the air, their use has lately been discarded in favour of Al_2O_3, which, after ignition in the muffle, gives no blank, nor does it absorb CO_2; on this account it is preferable to either of the other two, and is now regularly used by the author as a standard reagent.

The furnace used is of the Bunsen type, with Finkener's burners, but the firebrick clays are replaced by asbestos arches with an extra arch over the boat as illustrated by Leffler (CHEMICAL NEWS, vol. lxxxv., p. 121). This arrangement ensures a sufficiently high temperature—no blast whatever being required. The combustion tube (porcelain 26"×1¼") is covered with asbestos cloth or mill-board. It is packed as usual with a few inches of copper oxide, and the cooler exit portion with granular

fused lead chromate to absorb sulphur compounds—the CuO and $PbCrO_4$ being separated by a large asbestos plug.

The gas purifying apparatus consists of a combined wash-bottle and tower as illustrated in Fig. 1.* The lower portion contains strong KOH solution through which the gas bubbles, and then passes through the top portion, which is filled with stick KOH supported by a perforated porcelain plate. The oxygen (from cylinder) and air have each their separate washing apparatus. Fig. 2 shows the absorption apparatus used, which consists of a modified Arnold's KOH bulb to which is attached a U-tube by means of a good fitting rubber cork. The addition of a third bulb to Arnold's tube increases its capacity to about 25 c.c., and as there is a corresponding increase of potash surface exposed to the gases passing through, it is made thoroughly efficient for very rapid working. The attached U-tube is two-thirds filled with dry calcium chloride, and one-third with soda-lime. The latter reagent should be replaced as soon as it becomes hydrated; in this manner the $CaCl_2$ will remain dry, and act as a safety-guard for a considerable period. The combined apparatus is suspended on the balance (Bunge's) by the bent exit tube of the KOH bulb. A similar bulb and tube containing respectively pure H_2SO_4 and $CaCl_2$ are placed in front of the absorption bulb to dry the gases. The apparatus illustrated may be obtained from J. J. Griffin and Sons, London.

The Laboratory,
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NEW ETCHING FLUID FOR MICRO-METALLURGY.

By WM. RAMSAY, A.I.C.

Among the various etching solutions used in demonstrating the microstructure of alloys, and especially those of copper, ammonia finds a prominent place. The reaction depends largely on the absorption of atmospheric oxygen, and if the specimen is deeply immersed the etching proceeds very slowly; on the other hand, if it be near the surface the etching is relatively quicker, but apt to be irregular; so that successful etching, in many cases, can only be accomplished with great loss of time. Secondary reactions may also occur, especially with the alloys of the Cu-Zn and Cu-Sn series, crystalline patches of metallic copper being deposited, also insoluble oxides and carbonates to such an extent as to entirely mask the original structure of the polished surface.

In order to obviate these defects the author sought to introduce the necessary free oxygen into the ammonia by means of hydrogen peroxide, and was gratified to find the addition all that could be desired. The reaction takes place energetically, and is complete in a few seconds to a few minutes according to the strength of the mixture and the amount of etching required.

My usual procedure is to immerse the specimen in more or less dilute ammonia and then to gradually introduce H_2O_2 by means of a pipette. Oxygen is at once evolved and the etching takes place rapidly, evenly, and without any of the after effects produced by long etching. The crystalline facets and edges of the constituents are more clearly defined and often beautifully differentiated in various tints and colours.

For many purposes I find this new reagent better than ammonia, nitric acid, ferric chloride, &c., and feel confident that it will prove of value in the hands of other workers.

Birkenhead Iron Works,
June 9, 1903.

* This design is now being slightly modified, in order to overcome difficulties of manufacture.

QUALITATIVE AND QUANTITATIVE ANALYSIS OF COBALT COMPOUNDS.

By H. COPAUX.

The examination of cobalt compounds has enabled me to make certain analytical observations, which I have collected together in this paper.

Metallic cobalt and its compounds, such as they are met with commercially, are never pure. They often contain sulphur, phosphorus, copper, aluminium and lime, and always iron and nickel. When we have to deal with traces of impurities in a large excess of cobalt, and wish to purify the latter for example, the general qualitative method is found to be insufficient, and it is necessary to have recourse to more sensitive methods.

Those which I am about to describe, based, however, on known principles, have enabled me to recover 1 m.grm. of foreign metal in 1 grm. of cobalt. Further, as the estimation and separation of the cobalt still offers some difficulties in its execution, I have set myself to remove these difficulties in the second part of this research.

Detection of Impurities.

The Heavy Metals.—Sulphuretted hydrogen suffices to detect the presence of traces of the heavy metals in a slightly acid solution.

Zinc and Manganese.—To the dilute hydrochloric solution, add freshly dissolved cyanide of potassium until complete limpidity is obtained. Make alkaline with soda, then add a few drops of sulphide of sodium. The sulphides of zinc and manganese are precipitated without carrying down any cobalt.

Iron.—To the dilute solution add sulphocyanide of ammonium and compare the colour of the mixture with that of the original solution.

Nickel.—Though we can detect the presence of 1 part of cobalt in 2000 parts of nickel, by means of Ilinski and von Knorre's nitroso-β-naphthol (*Berichte*, vol. xviii., p. 699), the inverse problem is much more delicate.

Detection of Nickel by means of Cyanides.—Among the classic methods the best is that of Liebig, based on the difference in stability of the double cyanides in the presence of alkalis. To the solution of the chlorides we add an excess of cyanide of potassium, then bromine and potash. The cobalticyanide of potassium remains unchanged in solution; the double cyanide of nickel is transformed into the brown hydrated sesquioxide, which is precipitated.

This hydrate has no characteristic appearance. From the qualitative point of view, this is the great drawback to the method, which is, however, sensitive to one-thousandth part.

Detection of Nickel by means of Carbonic Oxide.—Messrs. Mond, Langer, and Quincke, in their paper on carbonyl of nickel (*Chem. Soc.*, 1890, vol. lvii., p. 749) advise the application of carbonic oxide to the detection and elimination of nickel in cobalt.

My experiments do not confirm this; they show, in fact, that the reaction, which is very sensitive with pure nickel, becomes the less so as the proportion of cobalt increases.

The metals in synthetic mixtures are precipitated in the state of hydrates. After reduction by hydrogen at 375—380°, then cooling in this gas down to 55—60°, I passed a current of carbonic oxide. The two dry gases, freed from oxygen by means of a tube containing red-hot copper, then dried again, were passed over the material and finally found their way into a capillary glass tube heated to about 400°.

Results.

1 m.grm. of pure Ni, gave a beautiful metallic ring, 6 to 7 c.m. in length.

1 m.grm. of Ni, and 0·1 m.grm. Co, gave a greyish transparent ring 1 c.m. in length.

1 m.grm. of Ni, and 1 m.grm. Co, gave an insignificant grey stain.

The diffusion of the metals in an inert body, such as alumina, did not improve the results.

The nickel remained in the residue with the cobalt. I made sure of this by the following means.

Detection of Nickel by means of Ether saturated with Hydrochloric Acid Gas.—M. Pinerua proposed in 1897 (*Comptes Rendus*, 1897, vol. cxxiv., p. 862), to separate nickel from cobalt by the difference of solubility of the chlorides in ether saturated with hydrochloric acid gas. The cobalt forms a soluble hydrochlorate of the chloride; the nickel is precipitated in the form of anhydrous chloride, yellow, crystalline, and very characteristic.

I have nothing to add to M. Pinerua's remarks, except that it is very easy to detect 1 m.grm. of nickel in 1 grm. of cobalt, and that on this principle I have based a method for the purification of cobalt. Ether, saturated with hydrochloric acid gas, in my opinion, is the best reagent for detecting traces of nickel in cobalt.

Quantitative Analysis.

I will limit myself to the question of the estimation of cobalt in the presence of nickel. Among the numerous reagents proposed, I prefer two only; nitroso-β-naphthol and nitrite of potassium.*

Nitroso-β-naphthol.—This reagent, of which I have already mentioned the extreme sensitiveness, precipitates cobalt from its hydrochloric solutions in the state of insoluble cobaltinitrosonaphthol. The corresponding compound of nickel, of which also the constitution is different, is, on the other hand, soluble.

The process has not been generally used for two reasons, viz., the considerable volume of the cobaltic precipitate, and, above all, the difficulty of calcining this body without loss owing to its being slightly explosive.

In 1893, von Knorre (*Zeit. Angew. Ch.*, 1893, p. 261) made an ingenious proposal, viz., to heat the moist precipitate, enveloped in its filter-paper, very rapidly in a platinum crucible. Under these conditions the substance is burnt without fusing.

Further, he proposed to weigh the product of the calcination, such as it was, and to consider it as being the oxide Co_3O_4; this, however, is inadmissible. Rose and Rammelsberg, in fact, have shown long ago that the calcined oxide of cobalt is a mixture of a variable composition.

I made another modification in this method, which consists of re-dissolving the oxide in concentrated hydrochloric acid, evaporating to dryness, and electrolysing the chloride in the presence of oxalate of ammonia. The results are fairly satisfactory.

	Theory.	Found.	
		I.	II.
Co	0·188	0·1899	0·1901
Ni	0·200	—	—

Still, the method is by no means so good as the following one, either in exactitude or convenience.

Nitrite of Potassium.—The cobaltico-potassic nitrite or cobaltinitrite of potassium, used in analysis since the time of W. Fischer in 1847, is a mixture of several salts (Rosenheim and Koppel, *Zeit. Anorg. Ch.*, 1898, vol. xvii., p. 35). The most abundant has the formula $Co_2(NO_2)_{12}K_6.2H_2O$. Its constitution is analogous to that of the cobalticyanides and of the cobaltioxalates of which I have written recently (*Comptes Rendus*, vol. cxxxiv., p. 1214).

The technique of the nitrite method, such as it is described in text-books of analysis, is the result of a research published by Gauhe in 1866 (*Zeit. Anal. Ch.*, 1866, vol. v., p. 74). It takes two or three days to make an analysis, and the instructions given are by no means sufficiently explicit; it is sometimes impossible to obtain any definite results. The whole of this want of success is due to the nitrous acid, and a complete precipitation can be obtained in twelve hours at the outside by operating in the following manner:—

Reagents.—(1) Nitrite of potassium at 40 per cent, slightly acidulated with nitric acid; (2) the same solution diluted to one quarter (10 per cent of nitrite).

Precipitation.—The solution of chlorides or nitrates, free from the heavy metals, from iron and the alkaline earths, is concentrated up to from 1 to 5 per cent of cobalt, and placed in a conical flask. One c.c. of concentrated nitric acid is added, then 15 c.c. of nitrite at 40 per cent. Instantly, and with effervescence, an orange-yellow precipitate of cobaltinitrite is formed.

When the solution has become perfectly clear, it is filtered through a small filter, and the precipitate washed with 15 c.c. of nitrite at 40 per cent, which is added to the mother-liquors with 0·5 c.c. of nitric acid.

After twelve hours, add the second precipitate to the first, and wash the whole with solution No. 2.

A third precipitation is rarely of any use unless the liquors become cloudy during filtration.

Solution and Electrolysis.—Place the precipitate with its filter in the flask used for precipitation, dissolve in hot dilute sulphuric acid. The filtered solution being neutralised with solid carbonate of ammonia, we add 4 or 5 grms. of oxalate of ammonia,* then electrolyse with a current of about 1 ampère per square decimetre, and an electromotive force of 3 to 4 volts.

	Co.	Ni.	Co.	Ni.	Co.	Ni.
Theory ..	0·1880	0·200	0·0188	0·200	0·1880	0·020
Found ..	0·1878	—	0·0194	—	0·1874	—

We see that the accuracy of the results is quite independent of the relative proportions of the two bodies present.

Analysis of an Asbolane.—I have applied the preceding method to the analysis of an asbolane (Herrenschmidt, *Mon. Scient.*, 1892, p. 359). Asbolane is a mineral of cobalt, which occurs very abundantly in New Caledonia; it is a compound of binoxide of manganese with protoxides in very variable proportions, according to the locality. It does not contain either arsenic or heavy metals. The sample I examined contained Mn, Co (6·2 per cent, Ni, Fe, and Al, with traces of Ba, Ca, Li, K, and Na. The whole difficulty of the analysis rests in the preliminary separation of the iron and aluminium, without carrying down any cobalt or manganese.

If a complete analysis is desired, carbonate of baryta is the only separating reagent that can be relied upon absolutely. If we wish merely to know the proportion of cobalt present, we can do this more rapidly by making the iron alone insoluble by M. Nicolardot's excellent method (*Comptes Rendus*, 1901, vol. cxxxiii., p. 686). For the sake of brevity I will give only the principle of the operations.

Complete Analysis.

Iron and Alumina.—Double precipitation with carbonate of baryta in the cold, in the presence of hydrochlorate of ammonia.

Nickel and Cobalt.—Precipitation by sulphuretted hydrogen, in acetic solution, of the filtrate freed from barium. The sulphides being re-dissolved in bromised hydrochloric acid, separate the cobalt by means of nitrite. On another sample, estimate the nickel by Liebig's cyanide process.

Manganese.—Estimation in the state of sulphide in the solution freed from iron, aluminium, nickel, and cobalt.

Abridged Analysis.—Heat the chlorides to 125° for several hours, and take up with sulphate of ammonia. Filter off the basic sulphite of iron, precipitate the filtrate

* Pinerua's method has given M. Carnot good results in the analysis of steels poor in nickel, but it is more applicable to the estimation of this latter metal than to that of cobalt. The same may be said of the cyanide methods.

* Oxalate of potash, recommended by Classen, carries a surcharge of 1 to 2 m grms. on the metallic deposit.

with sulphuretted hydrogen in aceti solution, and complete as before.

Results.

MnO	38·2
CoO	7·9
NiO	3·6
Fe_2O_3	3·5
Al_2O_3	18·8
Alkalis and alkaline earths	1·2
Active O	9·4
Total H_2O	15·8
SiO_2 and chromite	0·5
	98·9

Conclusions.—The question, so often discussed, of the analytical relations between nickel and cobalt, can be summed up as follows:—Carbonic oxide is a sensitive reagent for pure nickel, but it loses all its advantages when the nickel is allied with an excess of cobalt.

Qualitatively, ether saturated with hydrochloric acid gas is the reagent most likely to detect traces of nickel in cobalt.

Quantitatively, nitrite of potassium, used as I have described, remains the best reagent for the direct separation of cobalt, in a mixture containing cobalt and nickel.—*Bull. Soc. Chim.*, Series 3, vol. xxix., p. 301.

PROCEEDINGS OF SOCIETIES.

CHEMICAL SOCIETY.

Ordinary Meeting, Thursday, June 4th, 1903.

Dr. W. H. Perkin, F.R.S., Vice-President, in the Chair.

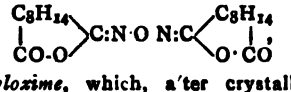
Certificates were read for the first time in favour of Messrs. Ernest Derwent, 36, Sixth and Railroad, Ironton, Ohio, U.S.A.; William Forster, 6, North Railway Street, Seaham Harbour; Edwin Reginald Hughes, 106, Queen Victoria Street, London, E.C.; Walter Ernest Jennings, 8, Rawdon Terrace, Ashby de la Zouch; William Parry, B.Sc., 23, Mount Pleasant, Waterloo, Liverpool.

The following certificate was authorised by the Council under By-law I. (3):—Wilfrid William Ogilvy Beveridge, A.M.S. Laboratory, Pretoria.

Of the following papers, those marked * were read:—

*83. "*Formation of an Anhydride of Camphoryloxime.*" By T. M. Lowry.

When nitrocamphor is boiled with concentrated hydrochloric acid, the greater part of the substance passes into solution, and is converted into camphoryloxime. During the investigation of this isomeric change (*Trans.*, 1898, lxxiii., 1002), a considerable quantity of a resinous by-product was accumulated; this substance has now been examined and found to contain an *anhydride*,—



of *camphoryloxime*, which, after crystallisation from alcohol, softens at about 215°, melts at 220°, and has $[\alpha]_D = +26°$ in acetone.

*84. "*Mutarotation of Glucose as Influenced by Acids, Bases, and Salts.*" By T. M. Lowry.

Both acids and bases have an accelerating effect on the mutarotation of glucose, whilst potassium chloride is without influence. If the mutarotation is conditioned by the presence in the glucose of an exceedingly minute quantity of basic impurity or a somewhat larger amount of acid impurity, a retardation should be produced when the base or acid is neutralised by adding hydrogen chloride or potassium hydroxide respectively. Careful quantitative experiments showed that this retardation does not occur, and the conclusion is drawn that although the mutarotation is accelerated by both acids and bases, its occurrence is independent of the presence of these impurities. Probably the water alone is sufficient to condition the change if enough impurity is present to render it an electrolyte.

*85. "*The Solubility of Dynamic Isomerides.*" By T. M. Lowry.

Whilst the rotatory power affords a general method for studying the dynamic isomerism of optically active substances, no similar method is available in the case of inactive bodies. The measurements of electrical conductivity, so effectively employed by Hantzsch in the study of pseudo-acids, pseudo-salts, and pseudo bases, can only be made when one of the isomerides is an electrolyte and at least moderately soluble in water. Of the other physical properties, density, molecular solution volume, refractive index, dispersion, and magnetic rotatory power differ relatively little in isomeric compounds, and the melting point, colour, and ultra-violet absorption cannot easily be made the basis of quantitative measurements. The solubility of dynamic isomerides is, however, usually very different, and under certain conditions it is possible to follow experimentally the gradual change of solubility as a substance is converted into a dynamic isomeride. This method, which has been devised and tested in the case of optically active substances, will, it is believed, be of service in the study of inactive bodies, and thus render possible the quantitative examination of many changes that have hitherto been examined only qualitatively.

If the less soluble isomeride is initially in contact with the solvent, the solubility gradually increases until the liquid phase contains a normal proportion of the two forms. If, however, the more soluble isomeride is used, the solubility increases until the liquid is saturated with both forms; the solution then contains a much greater proportion of the more soluble isomeride, and isomeric change proceeds continuously, the more soluble modification dissolving whilst the less soluble form separates from the solution; finally, when the whole of the more soluble form has dissolved, the solubility decreases to a constant value identical with that obtained when the less soluble isomeride alone is used.

Measurements of the solubility of pseudo-*s*-bromonitrocamphor in benzene show that at 10° the solubility gradually increases from 2·3 to 9·3 grms. per 100 grms. of benzene, whilst when both forms are present in the solid phase the solution contains nearly 14 per cent of the substances.

*86. "*The Rusting of Iron.*" By G. T. Moody.

The contention of Dunstan (*Proceedings of the Royal Artillery Institution*, 1899, No. 5, xxvi.; *Proc.*, xix., p. 150) that carbon dioxide is not essentially concerned in the process of rusting, and that this change is caused by hydrogen peroxide is based on the observation that solutions of chromium trioxide, potassium dichromate, potassium ferrocyanide, sodium nitrite, and other substances which decompose hydrogen peroxide, entirely or nearly entirely prevent rusting. The author finds that the retarding action exercised by these substances is due to the influence they exert on the absorption of carbon dioxide. For example, when exposed to the gas under exactly the same conditions, water absorbed 90·6 volumes, whilst a 15 per cent solution of chromium trioxide and a 20 per cent solution of sodium nitrite absorbed 4·2 volumes and 5·6 volumes respectively. A solution of chromium trioxide—which itself does not attack iron—appears all the more to exert a protecting influence because of the ease with which it dissolves ferric oxide. Iron, when placed under a one per cent solution of chromium trioxide exposed to air, remains bright for some weeks, although the metal is slowly passing into solution. Eventually rust commences

to form on the metal, although the solution still contains free chromic acid.

When iron is exposed to water and oxygen previously freed as far as possible from carbon dioxide, the volume of oxygen remains practically unchanged. On admitting carbon dioxide, the volume of oxygen diminishes rapidly, and rusting becomes visible.

The interaction of iron with aqueous carbonic acid appears to be strictly comparable with that occurring between iron and sulphuric acid. A solution of carbonic acid, formed by saturating 2·4 litres of water at 18° with carbon dioxide, when left in contact with 500 grms. of clean iron turnings, yielded 635 c.c. of hydrogen in seven days. After remaining for one week, the solution contained 0·1 per cent of iron present as ferrous bicarbonate, a substance which is readily decomposed by atmospheric oxygen yielding a mixture of ferrous carbonate and ferric oxide, whilst a part of the carbonic acid is regenerated. On account of the ease with which this change takes place, it follows that in presence of oxygen a definite weight of carbonic acid will exert a greater corroding influence on iron than will its equivalent of sulphuric or hydrochloric acid.

The author contends that the primary action in rusting involves the interaction of iron and acid, and that rust is formed by the subsequent oxidation of ferrous salt.

Discussion.

Mr. C. E. Groves said it was known that iron immersed in potassium carbonate solution did not rust, and asked whether the author had examined the action on iron of a solution of *potassium* hydrogen carbonate saturated with carbon dioxide. He believed it was not generally known that solid caustic potash containing about 5 per cent of water, when fused at a gentle heat in contact with steel, readily attacked it, the iron apparently forming a ferrous compound. Fused caustic soda, however, had practically no action on iron.

Dr. Jowett said that, having co-operated with Prof. Dunstan in the work to which Dr. Moody had referred, he must point out that much of the criticism seemed to be based on a misunderstanding. The rusting of iron was the sum of several chemical reactions each of which had been separately studied. It was not stated or thought that the oxidation in which hydrogen peroxide might take part constituted the whole phenomenon of rusting, and one of the experiments shown by Dr. Moody, namely, the evolution of hydrogen from a mixture of aqueous carbonic acid and iron, was referred to in Prof. Dunstan's note. The oxidation in which it was suggested that hydrogen peroxide was involved, occurred when oxygen, water, and pure iron were used, and it was a fact that substances which decomposed hydrogen peroxide prevented oxidation under conditions similar to those in which the peroxide was produced during the oxidation of zinc.

Finally, although the analyses of rust produced under ordinary atmospheric conditions generally showed the presence of carbon dioxide, they agree closely with the formula $Fe_2O_2(OH)_2$, which was also found to represent the composition of the product formed by the oxidation of iron under the conditions previously mentioned.

Dr. Scott asked if the chromic acid was free from sulphuric and nitric acids.

He mentioned that Dr. Russell's experiments on the action of various metals on photographic plates showed that zinc very readily gave hydrogen peroxide and even mercury containing 1/300th per cent of zinc produced sufficient to affect a photographic plate.

Dr. Kohn asked whether any experiments had been tried on the influence of light on the action of carbonic acid, since many changes effected by air and moisture and attributed to the formation of hydrogen peroxide did not occur or were diminished in absence of light. Such experiments might indicate whether hydrogen peroxide had any contributory action.

Mr. A. C. Chapman asked whether Dr. Moody had assured himself that the amount of hydrogen evolved in the experiment referred to was not greater than that which would correspond with the carbon dioxide present, and also whether he had made any experiments as to the influence of the purity of the iron employed on the quantity of gas evolved. In other words, was the hydrogen solely the result of replacement, or might not some of it have been produced by electrolytic action pure and simple.

Dr. Henry pointed out that in the course of the experiments referred to in Prof. Dunstan's note, a specimen of pure sheet iron with bright surfaces had been immersed for more than six years in a 4 per cent aqueous solution of chromic acid contained in a loosely stoppered jar; during the whole of that time the surfaces had remained perfectly bright, and there was no evidence of either the reduction of the chromic acid or the formation of iron rust, although the solution was in contact with atmospheric carbon dioxide. He suggested that the rusting observed by the author when iron was kept in solutions of dilute chromic acid in presence of carbon dioxide might be due to the employment either of commercial iron or chromic acid containing impurities; it was known that the presence of neutral salts such as sodium chloride in water in which iron was immersed accelerated the rate of rusting.

Dr. Lowry said that if hydrogen peroxide were a product of the initial stage in the rusting of iron, its destruction by chromic acid might be expected to assist rather than retard the oxidation.

Dr. Moody, in reply, said that in discussing this subject it was necessary to be agreed as to what was meant by rusting. He understood rusting to mean the corrosion taking place when metals were left exposed to air under ordinary conditions. Water condensed from air contains carbonic acid, which in contact with iron immediately gives rise to a ferrous salt. Since ferrous salts equally with chromic acid, sodium nitrate, and potassium ferrocyanide establish a condition in which the production of hydrogen peroxide is inhibited, it follows that the theory advanced by Dunstan can have no bearing on the atmospheric rusting of iron.

87. "*Imino-ethers Corresponding with Ortho-substituted Benzenoid Amides.*" By G. D. Lander and F. T. Jewson.

Pinner's method of synthesis of imino-ethers fails either partially or completely with aryl cyanides containing an *ortho*-substituent, and one of the authors has shown that the main product of the action of ethyl iodide and dry silver oxide on *o*-toluamide in boiling alcoholic solution is a nitrile (*Trans.*, 1901, lxxvii., 695).

When boiling alcohol is employed as a medium, the alkylation of other amides by this method seems to be characterised by the formation of nitriles, but whilst the yield of imino-ether from *o*-toluamide is only 13·6 per cent, the proportion is 70 per cent in the case of *p*-toluamide; this result is explained by supposing that the *o*-compound more readily loses alcohol than its *p*-isomeride, $C_7H_7.C:NH\cdot OEt = C_7H_7\cdot CN + EtOH$. The same constitutive factor, however, renders the *o*-imino-ether more stable as regards hydrolysis by aqueous hydrochloric acid, $C_7H_7C:NH\cdot OEt + H_2O + HCl = C_7H_7\cdot CO_2Et + NH_4Cl$.

Although better yields of the imino-ether are obtained when the synthesis is carried out in boiling ethereal solution, yet in this case nitrile is also produced.

The *hydrochloride* of *o*-chlorobenziminoethyl ether decomposes at 105°, yielding *o*-chlorobenzamide; the *methyl* analogue forms a *hydrochloride* which decomposes at about 110°. o *Chlorobenzmethylamide* is also a product of the methylation of *o*-chlorobenzamide, and forms colourless needles melting at 92—94°. o-*Toluiminomethyl ether* was prepared by the action of methyl iodide on the silver derivative of *o*-toluamide; its *hydrochloride* decomposes between 110° and 115°. o-*Toluiminoethyl ether*, when mixed with nitrile, distils without change between 106° and 118° under 20—25 m.m. pressure, and yields a *hydrochloride* which decomposes at 105—106°;

88. "*The Hydrolysis of Ethyl Mandelate by Lipase.*" By H. D. Dakin.

Optical isomerides are frequently very differently affected by enzymes as well as by living organisms, but the production of an optically active substance from inactive material as the result of simple enzyme action has not hitherto been conclusively demonstrated.

If the conception of an enzyme as an optically active asymmetric complex is correct, and, moreover, if combination occurred between the enzyme and the substance acted on, it should be possible to show that when an enzyme acts on an optically inactive substance, the two optical components are decomposed with unequal velocity.

This was shown to be the case when inactive ethyl mandelate was hydrolysed by the enzyme lipase. In all cases, provided hydrolysis was incomplete, the separated mandelic acid was found to be strongly dextrotatory whilst the unchanged ester was lævorotatory.

The reaction would appear to bear a close analogy to the hydrolysis of esters prepared from an optically active alcohol and an inactive acid (Marckwald and McKenzie, *Ber.*, 1901, xxxiv., 469).

89. "*Isomeric Change in Benzene Derivatives. The Conditions Influencing the Interchange of Halogen and Hydroxyl in Benzenediazonium Hydroxides.*" By K. J. P. Orton.

The supposed *s*-tribromophenylnitrosoamine, obtained by Hantzsch and Pohl (*Ber.*, 1902, xxxv., 2964) from *s*-tribromobenzenediazonium acetate under conditions which, according to the author's earlier investigations (*Proc. Roy. Soc.*, 1903, lxxi., 153), are favourable to the replacement by hydroxyl of the bromine atom in the ortho-position relatively to the diazo-group, is now shown, by an exact repetition of Hantzsch and Pohl's experiments, to consist of a mixture of 3 : 5-dibromo-*o*-quinonediazide (3 : 5-dibromo-*o*-diazophenol) and an amorphous condensation product, probably a hydroxyazo-derivative, either when prepared from the diazonium salt or from the corresponding alkali diazo-oxide (diazotate). Moreover, the hydrochloride obtained by Hantzsch and Pohl by passing hydrogen chloride into an ethereal solution of the original yellow material, and thought by them to be the hydrochloride of the nitrosoamine, is, in fact, the hydrochloride of the quinonediazide, which can readily be prepared from it by hydrolysis with water.

The transformation of the diazonium acetates derived from 2 : 4 : 6-tribromo-3-nitroaniline, 2 : 3 : 4 : 6 tetrabromoaniline, 3 : 5-dibromo-*p*-toluidine, 2 : 6-dibromoaniline, 2 : 4-dichloroaniline, and 2 : 4-dibromo-5-nitro aniline have been examined. When a nitro-group is in the meta-position relatively to the diazo-group, the replacement of the *o*- or *p*-bromine atom by hydroxyl takes place very readily, the diazo-compound in this respect resembling the naphthalene derivatives (*Proc.*, 1902, xviii., 252). It is remarkable that 3 : 5-dibromo *p*-toluenediazonium acetate does not lose bromine.

2 : 6 Dibromobenzenediazonium acetate slowly undergoes this change, but chlorine ions are scarcely appreciable in a solution of 2 : 4-dichlorobenzenediazonium acetate, even after several days. Bromine is, however, rapidly displaced when a nitro-group is in the meta-position relatively to the diazo-group, as in the 2 : 4-dibromo-5-nitrobenzene diazo-compounds.

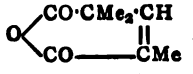
This interchange takes place not only with the diazonium acetates and hydrogen carbonates, but also in a similar manner with the salts of other weak acids, such as the cyanides and the nitrites, but with these salts, however, other reactions occur simultaneously, thus 2 : 4 : 6-tribromo-1-nitrobenzene is also formed from the nitrite.

When the diazonium salt is present as sulphate, the change is extremely slow at the ordinary temperature, but at 80° nearly one atomic proportion of bromine is eliminated in four hours, a fact which no doubt accounts for the apparent impossibility of obtaining *s*-tribromophenol by heating aqueous solutions of *s*-tribremobenzenediazonium salts.

The following substances were described:—2 : 4 : 6-*tribromobenzeneazo-β-naphthol*, melting at 173—174°; 3 : 5-*dibromophenol-2-azo-β-naphthol*, copper-coloured plates melting at 214—215°; 3 : 5-*dibromo-2-nitro*-p-*quinonediazide* (3 : 5 *dibromo-2-nitro*-p-*diazophenol*), prepared from 2 : 4 : 6-tribromo-3-nitroaniline, crystallises in yellow plates decomposing at 196°; *tribromoquinonediazide* (*tribromodiazophenol*), prepared from 2 : 3 : 4 : 6-tetrabromoaniline, forms orange crystals melting and decomposing at 124°; 3-*bromo-o-quinonediazide* (3-*bromo-o-diazophenol*), prepared from 2 : 6-dibromoaniline, crystallises in orange needles melting and decomposing at 103°; 2 : 4-*dichlorobenzeneazo-β-naphthol*, scarlet prisms melting at 190°; *chlorophenolazo-β-naphthol*, minute needles melting at 265°; 3 : 5-*dibromo*-p-*tolueneazo-β-naphthol*, scarlet prisms melting at 141°.

90. "*The Synthesis of αα'γ-Trimethylglutaric Acid, of the* cis- *and* trans-*Modifications of β-Hydroxy-αα'γ-trimethylglutaric Acid, and of αα'γ-Trimethylglutaconic Acid.*" By W. H. Perkin, jun., and Alice E. Smith.

A mixture of ethyl dimethylmalonate and ethyl acetate is readily acted on by sodium, yielding the sodium compound of ethyl *αα*-dimethylacetonedicarboxylate, $CO_2Et{\cdot}CMe_2{\cdot}CO{\cdot}CHNa{\cdot}CO_2Et$, and if this is treated with methyl iodide, *ethyl αα'γ-trimethylacetonedicarboxylate*, $CO_2Et{\cdot}CMe_2{\cdot}CO{\cdot}CHMe{\cdot}CO_2Et$, is produced as a nearly colourless oil boiling at 195—197° under 100 m.m. pressure, which, in alcoholic solution, gives a violet coloration with ferric chloride. When this ester is reduced with sodium amalgam, it yields a mixture of the *cis*- and *trans*-modifications of *β-hydroxy-αα'γ-trimethylglutaric acid*, $CO_2H{\cdot}CMe_2{\cdot}CH(OH){\cdot}CHMe{\cdot}CO_2H$. The *trans*-acid melts at 155°, and when rapidly heated under reduced pressure distils with very little decomposition. The *cis*-acid melts at 115°, and on distillation yields a crystalline substance, $C_8H_{10}O_3$, which melts at 88°, and is probably the anhydride of cis-*αα'γ-trimethylglutaconic acid*,—



Both the *cis*- and *trans*-modifications of the hydroxy-acid, when treated successively with phosphorus pentachloride and diethylaniline, or when digested with fuming hydriodic acid, are converted into trans-*αα'γ-trimethylglutaconic acid*; this acid, which melts at 150°, and, when heated in small quantities, volatilises to a certain extent without decomposition, is reduced with difficulty, but by the action of a large excess of alcohol and sodium becomes converted into *αα'γ-trimethylglutaric acid*, $CO_2H{\cdot}CMe_2{\cdot}CH_2{\cdot}CHMe{\cdot}CO_2H$, melting at 98°. When subjected to the action of dry bromine vapour, *trans αα'γ*-trimethylglutaconic acid is converted into *βγ-dibromo-αα'γ-trimethylglutaric acid*, which crystallises from formic acid, and melts at 205—207°.

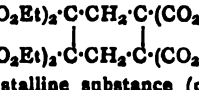
91. "*Hexamethyleneoctocarboxylic Acid and the* cis- *and* trans-*Modifications of Hexamethylenetetracarboxylic Acid* (*Hexahydropyromellitic Acid*)". By T. W. D. Gregory and W. H. Perkin, jun.

When ethyl propanetetracarboxylate,—

$$(CO_2Et)_2CH{\cdot}CH_2{\cdot}CH(CO_2Et)_2,$$

is treated with bromine, it yields *ethyl dibromopropanetetracarboxylate*, $(CO_2Et)_2CBr{\cdot}CH_2{\cdot}CBr(CO_2Et)_2$, which melts at 55°.

This bromo-ester reacts with the disodium compound of ethyl propanetetracarboxylate giving an almost quantitative yield of *ethyl hexamethyleneoctocarboxylate*,—



a colourless, crystalline substance (m. p. 46°), which, when digested with hydrochloric acid, yields the free *hexamethyleneoctocarboxylic acid*; this substance decom-

poses at 218°, giving rise to the *cis*- and *trans*-modifications of *hexamethylenetetracarboxylic acid*,—

$$\begin{array}{l} CO_2H\cdot CH\cdot CH_2\cdot CH\cdot CO_2H \\ \quad\quad\quad\quad | \quad\quad\quad | \\ CO_2H\cdot CH\cdot CH_2\cdot CH\cdot CO_2H \end{array}.$$

The *cis*-acid melts at 140°, and its *anhydride* at 60; the *trans*-acid melts at 175°, and yields the latter compound on digestion with acetic anhydride and subsequent distillation.

92. "*The Bases contained in Scottish Shale Oil.*" Part II. By F. C. GARRETT and J. A. SMYTHE.

The only bases obtained in a state of purity from the fractions of Scottish shale oil boiling between 164° and 180° are 2:3-*dimethylpyridine* and 2:4:6-trimethylpyridine. The lower homologue, which has not been described, is a liquid lighter than, and insoluble in, water, having a pleasant aromatic smell, and boiling at 163—164° under 768 m.m. pressure. Its mercurichloride melts at 120°, and its aurichloride at 96°; its platinichloride melts and decomposes at 216°. The trimethylpyridine boils at 171° under 768 m.m. pressure, and gives an aurichloride containing one molecule of water of crystallisation, and melting at 53°; when anhydrous, the salt melts at 112°.

93. "*A Direct Method for Determining the Latent Heat of Evaporation.*" By J. CAMPBELL BROWN.

The latent heats of thirteen alcohols, seven acids, and twenty-eight esters have been directly determined by means of an apparatus adapted for ascertaining the weight of liquid evaporated by a determinate amount of heat applied at the boiling-point of the substance, when this is surrounded by a double jacket containing its own vapour.

94. "*Isomeric partially Racemic Salts containing Quinquevalent Nitrogen.* Part X. *The Four Isomeric Hydrindamine* d-*Chlorocamphorsulphonates*, $NR_1R_2H_3$." By F. S. KIPPING.

The isomeric partially racemic α- and β-salts obtained from *dl*-hydrindamine and *d* chlorocamphor-ulphonic acid (*Trans.*, 1900, lxxvii., 889) are not resolved into their components under conditions similar to those employed in the resolution of the corresponding bromo-salts (*Proc*, 1902, xviii., 209), but the four isomeric salts of the type $NR_1R_2H_3$, from which the partially racemic compounds are formed, have been isolated and examined.

d-Hydrindamine, prepared from the pure *ad*-bromo-salt (previously denoted αA-salt, *Proc.*, *loc. cit.*), combines with *d*-chlorocamphorsulphonic acid, giving rise to two isomeric salts, one of which is formed in relatively very small quantities. The principal product, which corresponds with the *ad*-bromo-salt and is distinguished as the *ad*-isomeride, is easily obtained in a pure condition; it separates from water in well-defined, compact, hydrated crystals, melts at 208—209°, and has a specific rotation $[\alpha]_D = +46°$ in aqueous and +15·5° in chloroform solution. It differs greatly in outward properties from the corresponding *ad*-salt of the bromo-acid, and also from all the other three isomeric chloro-salts.

The second product, which corresponds with the *βd*-bromo-salt (previously denoted βA-salt), is only obtained in a pure condition after a long course of fractional crystallisations; it separates from water in long, hydrated needles, melts at 202—203°, and its specific rotation in aqueous solution is $[\alpha]_D = +59°$, the value in chloroform being $[\alpha]_D = +50°$.

The great difference between these isomerides is very noteworthy considering the fact that the corresponding bromocamphorsulphonates of hydrindamine and of methylhydrindamine (Tattersall and Kipping, *Proc.*, xix., p. 145) are so similar that the *βd*-isomeride cannot be obtained in a pure state.

The pure *ad*-hydrindamine chlorocamphorsulphonate, decomposed with barium hydroxide solution, gives both the *ad*- and the *βd*-isomerides when regenerated from its component acid and base, a proof that these two salts are formed from structurally and optically identical components.

Hydrindamine, prepared from the pure *al*-modification (previously denoted αB) of the bromo-salt, also combines with *d*-chlorocamphorsulphonic acid, giving rise to a mixture of very unequal quantities of two isomeric salts. The principal product, the *al*-modification, corresponding with the *al*-bromo-salt, separates from water in long, anhydrous needles, indistinguishable in appearance from those of the *al*-bromo-compound; it melts at 118—119°, and has a specific rotation $[\alpha]_D = +44°$ in aqueous and +45·5° in chloroform solution. The subsidiary product, namely, the *βl*-isomeride (formerly denoted βB), is only separated in a pure condition with very great difficulty; it crystallises from water in long, anhydrous needles which generally melt at about 140—145°, the indefinite melting-point being apparently due to dimorphism, as in the case of the corresponding bromo-isomeride. Its specific rotation is $[\alpha]_D = +57·5°$ in aqueous and +60·5° in chloroform solution.

When the pure *al* chloro-salt is decomposed with barium hydroxide solution and then regenerated from its own acid and its own base, a mixture of the *al*- and *βl*-isomerides is obtained, just as from the original *l*-base.

It is to be noted that the *βd*- and *βl*-chloro-salts have a much *higher* molecular rotation than that of *d*-chlorocamphorsulphonic acid, whereas in the case of the corresponding bromo-salts the position is reversed; it follows, therefore, that the formation of these isomerides cannot be attributed to any partial racemisation of the acid or the base.

The isolation of these four isomeric hydrindamine *d*-chlorocamphorsulphonates seems to afford the final proof that the author's explanation of the existence of the partially racemic α- and β-salts is the true one (*Trans.*, *loc. cit.*).

95. "*Isomeric Compounds of the Type* $NR_1R_2H_3$." By F. S. KIPPING.

The isolation of the four isomeric hydrindamine *d*-chlorocamphorsulphonates (see previous abstract), the proof of the existence of four isomeric methylhydrindamine bromocamphorsulphonates (derived from one *dl*-base) (Tattersall and Kipping, *Proc.*, xix., p. 145), and other evidence fully confirm the author's views as to the nature of the isomeric partially racemic salts which have been previously studied (Kipping, *Trans.*, 1900, lxxvii., 861; 1901, lxxix., 430), and establish the occurrence of isomerism in compounds of the type $NR_1R_2H_3$ (*Proc.*, 1902, xviii., 211).

The stability of the isomeric salts in aqueous solution leads to the conclusion that there are two different ions NR_1H_3— for each optically active base, and, consequently, it should be possible to transfer such ions from one acid to another without altering the configurations particular to them. Experiments bear out this conclusion. The partially racemic β-salt of hydrindamine and *d*-bromocamphorsulphonic acid is not converted into the corresponding α-salt when it is repeatedly evaporated first with concentrated hydrochloric acid, and then with water, or when it is successively treated in aqueous solution with sodium carbonate and hydrochloric acid, the solution being then evaporated. The four basic ions of the β-salt can thus be transferred from the bromo-acid to hydrochloric acid or to carbonic acid, and back again to the bromo-acid without altering their relative proportions as long as the base is never in the free state.

The platinichlorides, prepared from the *ad*-, *al*-, and *βl*-modifications [previously called the αA-, αB-, and βB-modifications respectively (*Proc.*, 1902, xviii., 209)] of hydrindamine *d*-bromocamphorsulphonate by precipitating in presence of hydrochloric acid, seem to be identical in outward properties, and the hydrochlorides obtained from the platinichlorides by decomposing with hydrogen sulphide are also indistinguishable in appearance and in melting-point; it would seem, nevertheless, that each of the optically active hydrindamines gives rise to two different

hydrochlorides (indistinguishable in ordinary properties), firstly, because of the behaviour of the partially racemic β-salt (see above), and, secondly, because the *βl*-modification of hydrindamine *d*-chlorocamphorsulphonate can be converted into a hydrochloride from which the original *βl*-salt is obtained on evaporating with the chloro-acid.

The hydrochloride, prepared from the above-mentioned *βl*-bromo-salt, gave with ammonium *d*-bromocamphorsulphonate what appeared to be the pure *βl* isomeride, but on repeating the experiment under different conditions, starting from the *βl*-chloro-salt, the *al* modification was obtained; further investigation is necessary before this difference in behaviour can be explained, but it seems reasonable to conclude that *four isomeric hydrochlorides* of hydrindamine are capable of existence.

The molecular rotations of the *ad*- and *al*-salts in dilute aqueous solution are in all cases practically normal, but the *βd*- and *βl*-hydrindamine bromocamphorsulphonates give values which are far too low, whereas the *βd*- and *βl* hydrindamine chlorocamphorsulphonates give numbers which are far too high; molecular weight determinations in boiling aqueous solution seem to indicate that the salts of the β-series are not so highly dissociated as the corresponding α-salts, but the evidence is very inconclusive.

The existence of isomeric salts of the type $NR_1R_2H_3$ can be accounted for by assuming that the five valencies of the nitrogen atom are directed from the centre to the angles of a square-based pyramid, but in view of the highly conflicting experimental evidence bearing on the question of the configuration of the nitrogen atom, this subject cannot yet be profitably discussed; even in the case of trivalent nitrogen, there is great uncertainty, as no case is yet known of isomerides of the type $NR_1R_2R_3$, although the existence of such compounds is a probable, if not a necessary, consequence of the hypothesis of Hantzsch and Werner.

PHYSICAL SOCIETY.

Ordinary Meeting, June 5th, 1903.

Dr. R. T. Glazebrook, F.R.S., President, in the Chair.

The Meeting was held, by invitation of Prof. Trouton, in the Physical Laboratory, University College.

Prof. Rutherford read a paper on "*Radio-active Processes.*"

There are three distinct types of radiation spontaneously emitted from radio-active bodies, which may be called the α, β, and γ rays. The α-rays are prominent in causing the conductivity of a gas, they are easily absorbed by metals, and are projected bodies, not waves. These bodies are about the size of a hydrogen atom, they are positively charged and travel with about one-tenth of the velocity of light. The β-rays are similar in all respects to the cathode rays produced in a vacuum tube. The γ rays are probably like Röntgen rays, but of very great penetrating power. The α-rays are by far the most important. In addition to these rays, two of the radio-elements give off radio-active "emanations," which are in all respect like gases. The radiations from these emanations are not permanent, but fall off in a geometrical progression with the time. The radiation of the thorium emanation falls to half value in one minute, that from radium in four days. They have all the properties of gaseous matter in infinitesimal quantity. Their coefficients of diffusion can be measured, the order of their molecular weights is 100, they are occluded by solid compounds producing them, and may be condensed at low temperatures. The radium emanation condenses sharply at −150° C., the thorium emanation between −120° C. and −150° C. The two emanations excite on objects with which they come in contact two kinds of temporary radio-activity, that from the radium emanation decaying much faster than that from the thorium emanation. The latter decays in a G.P. with the time falling to half value in eleven hours. These effects appear to be produced by solid matter in invisible and unweighable quantity, which can be dissolved off in some acids, but not in others. On evaporating the solutions, the radio-activity is obtained unchanged in the residue. The experiments of Crookes and Becquerel in separating by chemical treatment the matter responsible for the activity of uranium, called uranium X, were referred to, together with the latter's observation that the separated activity had completely decayed after the lapse of a year, by which time the uranium itself had completely recovered its activity. The work of Rutherford and Soddy on thorium was then discussed in detail. Thorium precipitated in solution by ammonia retains only 25 per cent of its activity. If the solution is evaporated and ignited, the remaining 75 per cent is found in the extremely small residue left, which, by reason of its separation, is different chemically from thorium, and was called Thorium X. Left to themselves, the thorium gradually recovers its activity and the ThX loses it. The activity of the latter falls in a G.P. with the time, the half value being reached after four days. At any time the sum-total of the two activities is a constant. This would occur if the ThX were being continually produced by the thorium, and this was shown to be the case by precipitating thorium at definite intervals after its separation from ThX. The ThX, and not thorium, produces the thorium emanation. The production of ThX by thorium, of the emanation by ThX, and of the matter causing the excited activity by the emanation, are all changes of the same type, although the rates of change are distinct in each case. The change of uranium into uranium X is also similar, being the slowest of all. Twenty-two days elapse before uranium freed from ThX recovers one-half of its activity. In radium, the radium emanation is the first product produced, and since this in a solid is almost completely occluded, the activity of a radium salt after it has been obtained from its solution rises after precipitation to several times its original value, due to the occlusion of the emanation. In all three radio-elements a part of the radio-activity is non-separable, and this part consists only of α-rays. The β-rays only result at the last stages of the process that can be experimentally traced. In all cases the radiation, from any type of active matter, is a measure of the amount of the next type produced. Thus the radio-activity of ThX at any period throughout its life is always a measure of the amount of emanation it produces. These results find their explanation if it is supposed that the α particles projected form integral portions of the atom of the radio-active element. Thus, ThX is thorium minus one or more projected α particles. The emanation, similarly, is ThX less a further α particle, and so on. The non-separable activity is due to the atoms of the original radio-element disintegrating at a constant rate. The whole of the processes take place unaltered in velocity, apparently under all conditions of temperature, state of aggregation, and chemical combination. This is to be expected of a sub atomic change in which one system only is involved at each change. On this view, the spontaneous heat-emission of solid radium salts, discovered by Curie, is explained by the internal bombardment by the α particles shot off and absorbed in the mass of the substance. The amount of energy given out in these sub-atomic changes is enormous, and from Curie's experiments it can be deduced that each grm. of radium gives out 10^9 grm.-calories during its life, which is sufficient to raise 500 tons a mile high. It seems probable that the internal energy of atoms in general is of a similar high order of magnitude.

Sir Oliver Lodge congratulated Prof. Rutherford and Mr. Soddy upon the field of research which had opened up to them, and upon the way they were pursuing it. Referring to the fact that the temperature of a piece of radium is above that of its surroundings, he said that Prof. Rutherford's discovery that atoms of matter were thrown out by radium at one-tenth the speed of light

would account for energy-effects, and he thought it necessary that when energy passed from an unrecognised atomic to an irregular molecular form, that previously non-existent heat would be produced. The important point in Prof. Rutherford's work was that he had established the fact that one kind of matter is thrown off by another kind of matter, and had also measured the velocity and weight of the particles thus thrown off. We were accustomed to electrons being shot out by matter, but the proof that light atoms are thrown off from heavy atoms was the evolution or transmutation of matter experimentally demonstrated. The heavy atoms of radium appear to collapse and throw off atoms of low atomic weight; the remainder is unstable, and more matter is thrown off, the original atom getting, it is to be presumed, lighter and lighter—according to the view of the author of the paper. It might be thought that this hypothesis about the degradation and the instability of the atoms was mere speculation, but it was the most reasonable explanation of observed phenomena. And the reason he was thus cordially willing to accept it as a working hypothesis was because he had been indistinctly looking for some such effect, being guided thereto by pure theory. And that was the chief point he wished to bring forward.

According to an electric theory of matter, *i.e.*, on the view that an atom contained electrons with rapid interatomic movements obeying laws like astronomical laws, this instability ought to exist. Taking a formula by Prof. Larmor for the radiating power of an accelerated electric charge, Sir Oliver Lodge gave a rough proof of the latter statement (reproduced in *Nature* for June 11th). He stated, in conclusion, as a working hypothesis, that we must not suppose that atoms are permanent and eternal, and suggested that we may possibly find a rise and decay in ordinary matter, and find that the history of an atom may be written—in accordance with the analogy of solar systems and cosmic configurations generally. On the electric theory of matter, the falling together of electrons might produce the electric aggregate called an atom, and its subsequent gradual decay or separation into other forms would be accompanied by epochs of radio-activity.

Prof. W. E. Ayrton, after congratulating the author, said he would like to ask a question. Prof. Rutherford had shown us the discharge of an electroscope when a thick plate of metal was placed between a piece of radium and the instrument. Would the electroscope be affected if a piece of radium *completely* surrounded by an earthed *metal* casing was brought near to it? Again, if a piece of radium was insulated inside a completely closed metal box, would an electroscope, metallically connected with the outside of the box—the whole being placed in a very good vacuum—be charged, and if so, what would be the sign of the charge?

Prof. Everett found it difficult to believe that there was a sufficient store of energy in the atom to account for the effects observed. He asked if the phenomena were not due to resonance, the radium atoms being shaken asunder by vibrations in the ether to which they were responsive. These scattered atoms might knock asunder some of the atoms of neighbouring bodies, and so produce the β-rays.

Prof. S. P. Thompson pointed out that the notion of energy within the atom was based upon the statement that the temperature of a piece of radium was above the temperature of its surroundings. Without doubting the work of Curie, he thought that critical experiments should be made on this point before it could be looked upon as an accepted fact, or such large generalisations be based upon it.

Dr. Lowry called attention to the slender evidence on which the theory of atomic degradation had been based. The behaviour of thorium and ThX was precisely analogous to that of a substance like π-bromonitrocamphor, which exists in an inactive "normal" form as a neutral substance and a dielectric, but also in an active "pseudo" form, in which it is a strong acid and an electrolyte. Both forms are fairly stable in the solid state, but when dissolved are exceedingly labile, and the merest trace of impurity is sufficient to bring about an isomeric change which leads in the course of a few days or hours to a condition of equilibrium in which there are about 94 parts of the inactive normal to 6 parts of the active pseudo form. The curves representing the rate of recovery and decay of (electrolytic) activity are mathematically identical with those shown for the recovery and decay of radio-activity by the two modifications of thorium and uranium. There is, therefore, the strongest evidence in favour of the view that the conversion of thorium into ThX is a *reversible change*, and that the emanations and excited activity are merely physical phenomena.

Prof. Rutherford, in reply to Prof. Ayrton, said that in the first case discharge would take place, and that the result in the second case would depend upon the thickness of the walls, and therefore upon the nature of the rays which could pass through. He also pointed out that Dr. Lowry's explanation involved him in perpetual motion. It did not explain radio-activity, and it was difficult to see how it could account for the phenomena occurring in stages. Moreover, there was no reversible chemical action that went on at the same rate at a red heat as in liquid air. With regard to Prof. Everett's suggestion, it seemed that such a process would be even more wonderful than that suggested. The phenomena go on unchanged even when the substance is shielded from external influence by many inches of lead. He felt confident that Curie's observation of heat emission would prove to be well founded.

NOTICES OF BOOKS.

Tables for Students of Quantitative Chemical Analysis. Drawn up by Charles E. Fawsitt, Ph.D., B.Sc. Edinburgh: W. F. Clay. 1903. Pp. 23.

The tables given in this publication appear to be very similar to, if not identical with, those given in the appendices of many text-books. They consist principally of two or three examples of the calculation of results, a table of atomic weights, four pages of logarithms, and a table of formula weights, factors, and percentages, arranged in alphabetical order of substances. They are set out in a convenient manner, and will be handy to have in the laboratory.

Annual Reports. By E. Merck. Complete Series, Vol. XVI., 1902. Darmstadt. May, 1903. Pp. 209.

Merck's reports are so well known by now that it needs very few words to recall their usefulness and value. The one now before us deals with the latest advancements of pharmaceutical chemistry and therapeutics; the greater part is devoted to preparations, more especially the new ones, particulars of which are collected annually from medical papers throughout the world, and collated and epitomised for this Report by the Scientific Department at the Darmstadt works. By this means physicians and pharmacists are saved the trouble of referring to original sources. Among these notes there is an interesting one on radio-active substances and their dermato-therapeutic action in cases of lupus. The radio-active substance used was a whitish powder, being a mixture of barium chloride and radium chloride, and possessing a radio-active power 5200 to 19,000 times greater than that of uranium. The Report contains also a complete bibliographical index, as well as others for authors' names, diseases and symptoms, and a general index.

Sulphurised and Nitrated Compounds Derived from Sulphide of Carbon; Additions.—Marcel Delépine. In this paper the author describes the action of the acids on the nitro-substituted imidodithiocarbonic ethers, and also the acidylalkylthiosulphocarbamic ethers, $R''CO\atop R$>N.CS.SR'.—*Bull. Soc. Chim.*, xxix., No. 1.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 20, May 18, 1903.

Preparation and Properties of Cæsium-ammonium and Rubidium-ammonium.—Henri Moissan.—During his research on certain new compounds of cæsium and rubidium, the author prepares the compounds cæsium-ammonium and rubidium-ammonium, analyses them, and examines their properties. To obtain these compounds, liquid ammonia is brought in contact with the metal, the operation taking place in a current of dry carbon dioxide. The author utilises solutions of these compounds in liquid ammonia for the preparation of the carbides of cæsium and rubidium, and also of the corresponding acetylenic acetylides of these metals.

Theory of Colour Indicators.—P. Vaillant.—An indicator can be defined as a weak acid or base whose molecule, RH or ROH, has a different colour to that of the ion R. This, the author thinks, is not correct, because there is no mention of the colour of salts of the indicator; these latter being, in fact, the only bodies which take part in the reaction. He would alter the definition to the following:—An indicator is a weak acid or base whose colour differs from that of its salts. He performs several experiments to uphold this definition.

Electrolysis of Alkaline Earth Sulphides.—André Brochet and Georges Ranson.—For the electrolysis of the alkaline earth sulphides, platinum, iron, or nickel can be used as anodes. Carbon will also serve, but if for some reason the reaction becomes oxidising, the oxygen complicates matters by attacking the electrode. The addition of sodium chloride does not modify the general course of the reaction, but under these conditions iron or nickel behave as soluble anodes. Baryta being without action on the polysulphides, the authors examine whether the electrolysis of barium sulphide without a diaphragm could constitute a method of preparation of this base diminishing or suppressing the reduction of the polysulphides. The increase in density of the cathode current is of no interest, the effect being barely sensible.

Action of Ethyloxalyle on Mixed Organo-magnesium Compounds.—V. Grignard.—When an organo-magnesium compound acts on ethyloxalyle, an unexpected secondary reaction takes place. The first phase is normal, and represented by the equation—

$$\begin{matrix} CO_2C_2H_5 \\ | \\ COCl \end{matrix} + 2CH_3MgI = \begin{matrix} CO_2C_2H_5 \\ | \\ C(CH_3)_2OMgI \end{matrix} + MgICl;$$

then the ethyloxalyle, which is present in excess, reacts on this compound as an acid chloride, etherifying the alcohol function in the following manner:—

$$\begin{matrix} CO_2C_2H_5 \\ | \\ C(CH_3)_2OMgI \end{matrix} + ClCO\cdot CO_2C_2H_5 =$$

$$= MgICl + \begin{matrix} CO_2C_2H_5 \\ | \\ C(CH_3)_2O.CO.CO_2C_2H_5 \end{matrix},$$

i.e., a mixed oxalate of ethyl and of the glycolic ether, is formed.

New Method of Estimation of the Halogen Bodies in Organic Compounds.—H. Baubigny and J. Chavanne.—The authors' method for the estimation of halogen bodies in organic compounds is based on the use of an alkaline solution of bichromate in concentrated sulphuric acid. This mixture, when hot, energetically attacks organic matters, and if they contain chlorine or bromine these bodies are liberated in the free state, even in the presence of a silver salt, whilst iodine is oxidised and retained in the solution in the form of iodic acid. By this means the iodine is separated from the chlorine and bromine in a rapid manner.

Action of Alkaline Earth Bases on Alkaline Earth Salts of Pyrogallol-sulphonic Acids.—Marcel Delage.—The author describes the six substances which are prepared by the reaction of an alkaline earth base on a sulphonate of the same metal. These mixed compounds, containing in their molecule two different alkaline earth metals, are prepared under the same conditions as the homogeneous compounds.

New Method of Estimating Glycerin.—A. Buisine.—When potassium hydrate mixed with potash-lime acts upon glycerin at about 350°, the potassium acetate produced during the rise of temperature is decomposed in its turn nto methane a nd potassium carbonate. Therefore, at 350°, ithe reaction of potash lime on glycerin can be expressed by the equation $C_3H_8O_3 + 4(KOH) = 2(CO_3K_2) + 6H + CH_4$. Under these conditions, 725 c.m. of hydrogen and 242 c.m. of methane at 0° and 760° are obtained from 1 grm. of glycerin. This reaction can be applied to the estimation of glycerin by the measurement of the gaseous volume obtained.

MISCELLANEOUS.

The Metric System.—The Decimal Association, of Botolph House, Eastcheap, have published a pamphlet setting forth their reasons why the metric weights and measures should be made compulsory throughout the British Empire. They point out that at present we make difficulties for ourselves in relation to our foreign trade with metric countries, and lose business because we do not manufacture and sell in terms of the metric system. Another very good and powerful reason for the change is, we think, the relief that would be experienced by getting rid of our present confusing and complicated system of weights and measures, which are really familiar to very few people besides school-teachers; months, or even years, of our childhood are wasted in learning them, and in after-life most people have to refer to the "table-book." The period of transition from our old weights and measures to those of the metric system must necessarily be attended with some inconvenience, but the general feeling of the Chambers of Commerce, of the leading School Boards, and many other public bodies throughout the country is in favour of a short shrift of not more than two years, after which the new system should be compulsory.

The Aromatic Polycarbylamines.—Felix Kaufler.—The polycarbylamines are obtained by the action of potash and chloroform on the diamines, under well determined conditions, which are:—For 15 grms. of diamine, 100 grms. of potash dissolved in 200 c.c. of water, 40 c.c. of alcohol, 300 grms. of chloroform, and boiling for from two to five hours. *Paraphenylenedicarbylamine* crystallises in white rhombic tablets, becoming black at 40°, soluble in ether and benzene; it combines with bromine, giving a tetrabromide fusible at 137—138°. The *p*-phenylenedicarbylamine heated to about 230—250°, is transposed into the terephthalic nitrile, fusible at 222—223°. *Metaphenylenedicarbylamine* forms needles which become coloured when exposed to the air; they fuse at about 90° with decomposition, being transformed into the isophthalic nitrile, fusible at 154—155°. The 1.3.5-trimethyl-2.4-diamidobenzene, treated with chloroform and potash, gives a small quantity of hygroscopic needles which have been transformed into the corresponding nitrile; this latter fuses at 139—140°, and is the 1.3.5-trimethyl-2.4-cyanobenzene already known. The 2.4.6-triamidotoluene, treated under the same conditions, seems also to give a polycarbylamine; triamidomesitylene gives a compound fusible at 160°, which is the 1.3.5-trimethyl-2-oxy-4.6-diisocyanobenzene.—*Mon. f. Ch.*, vol. xxii., p. 1073.

Research on Lead and Manganese.—A. Trillat.—The tetramethyl base of diphenylmethane, $CH_2[C_6H_4N(CH_3)_2]_2$, in acetic solution, by reason of the formation of the corresponding hydrol, $CH.OH[C_6H_4N(CH_3)_2]_2$, gives a magnificent blue, stable at high temperatures with certain dioxides (lead, manganese, and copper). The application of this reaction, being very sensitive with the first two metals, can be applied as a means of detecting them.—*Comptes Rendus*, cxxxvi., No. 20.

MEETINGS FOR THE WEEK.

FRIDAY, 26th.—Physical (at the Physiological Laboratory, London University, South Kensington). Special General Meeting, 4.30. Science Meeting, 5. "Electrical Effects of Light upon Green Leaves," "Blaze-currents—(1) of a Vegetable Tissue, (2) of an Animal Tissue," and "Quantitative Estimation of Chloroform Vapour in Air by—(1) Oil Absorption, (2) Densimetry," by Dr. Waller. "The Temperature Limits of Nerve-action in Cold-blooded and in Warm-blooded Animals," by Dr. Alcock. "On the Movement of Unionised Bodies in Solution in an Electric Field" and "On the Passage of Nervous Impulses through the Central Nervous System," by Dr. Hardy.

Re Pirie *v.* The Company and Others.—The Electro-Chemical Co. (1900), Ltd., 1901, E. 85.—By orders of Mr. Justice Farwell.

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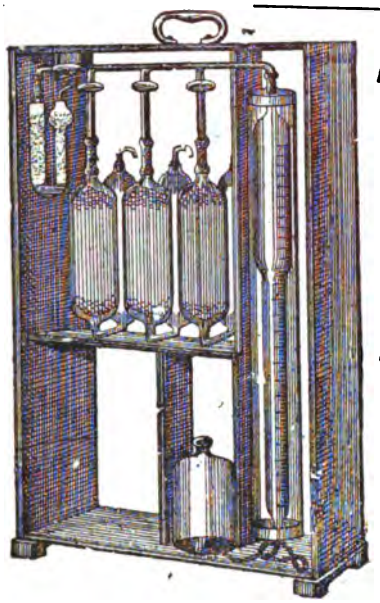

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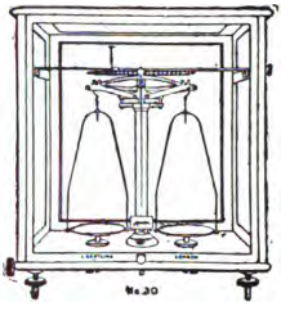

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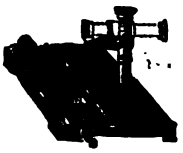

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THE CHEMICAL NEWS.

VOL. LXXXVII., No. 2274.

ON THE THEORY OF REFRACTION IN GASES.*

By GEORGE W. WALKER, M.A., A.R.C.Sc.,
Fellow of Trinity College, Cambridge.

THE present theories of refraction in gases lead to expressions for the refractive index, of which the formula—

$$\mu^2 - 1 = Nf(\rho)$$

may be taken as typical.

In the formula—

μ is the refractive index.
N is the number of molecules per unit volume.
ρ is the frequency of the waves.

and $f(\rho)$ is a function of ρ which depends on the assumptions made as to the constitution of the molecule.

The formula, although it explains the main features in the visible spectrum, cannot always be made to explain the measured temperature effects, even when allowance is made for the deviations from the gaseous laws of Boyle and Charles.

Again, in the case of the dielectric constant for some gases such as SO_2 and NH_3, the value of $K-1$ is much greater than the value of μ^2-1.

In such cases we find that μ^2-1 varies nearly as N, while $K-1$ is more nearly proportional to N/θ, where θ is the absolute temperature.

The theories are thus inadequate, and a modification is required which will give a greater dependence on temperature.

In the theories of Voigt and Lorentz the molecule is regarded as an aggregate of electrical doublets. The individual parts are assumed to have free periods of vibration, which are naturally identified with the spectral lines of the gas, and, therefore, must have a frequency independent of temperature.

The view adopted in the present paper is that, instead of free vibrations, we have constrained motion. Regarded from Prof. J. J. Thomson's point of view, the atom consists of a large positive particle and a large number of small negative ones. Instead of supposing that these negative particles can vibrate radially, I regard them as rolling on the surface of the positive one in constrained motion. The effective control on transmitted waves is thus the rotational energy of motion of the particles, and it must be proportional to the absolute temperature.

When, by collisions or otherwise the rotational motion becomes so great that the electric attraction is overcome by the centrifugal force, ionisation occurs. The frequency or frequencies of rotation at which this occurs are determined by the electrical attractions and are independent of temperature, although, of course, the higher the temperature the greater will be the amount of ionisation. I regard these frequencies as corresponding to the spectral lines, and it will be seen that the view explains the ionisation produced by ultra-violet light, and also agrees with the fact that luminosity is probably always connected with ionisation, *e.g.*, the characteristic lines come out in the electrical discharge through the gas.

Regarded simply as obstacles, the molecules must contribute a term to μ^2-1, which is proportional to N and practically independent of the frequency.

The final formula obtained is—

$$\mu^2 - 1 = k_1 N + \frac{k_2 N}{\theta} f(\rho, \theta),$$

where k_1 and k_2 are constants and $f(\rho,\theta)$ is a function of ρ and θ. The function is fully discussed in the paper.

The formula is shown to be capable of accounting for all the known facts connected with the dielectric constant and the refractive index, while the absorption of ultra-violet light and apparent absorption, due to selective reflexion in the infra-red, is also explained

Notwithstanding the very complex and varied facts in air, hydrogen, carbon dioxide, ammonia, and sulphur dioxide, complete numerical agreement between the measurements of $K-1$ and μ^2-1 as regards both absolute magnitude and dependence on pressure, temperature, and frequency, has been established.

* Abstract of a Paper read before the Royal Society, May 28th, 1903.

THE HYDROLYSIS OF FATS *IN VITRO* BY MEANS OF STEAPSIN.*

By Dr. J. LEWKOWITSCH
and
Dr. J. J. R. MACLEOD, Mackinnon Scholar.

A FEW months ago, one of us (J. L.) stated (*Journ. Chem. Soc. Ind.*, 1903, p. 67) that he had made a series of experiments in which lipase was allowed to act on cotton-seed oil, and that he had only been able to obtain hydrolysis amounting to 3 per cent. Dr. Macleod then suggested that it would be of considerable interest to ascertain the extent to which steapsin could carry the hydrolysis under the same conditions. We therefore decided to investigate this question conjointly, and we are now in a position to show beyond doubt that steapsin is capable of hydrolysing (saponifying) fats outside the organism to a very great extent. As this fact appears to us of considerable physiological importance, inasmuch as the quantitative experiments have hitherto been made almost entirely on monobutyrin and simple esters,† we publish this preliminary notice without referring to the literature *in extenso*. This will be done after the completion of the experiments we have in hand.

Preparation of the Steapsin Solution.

The steapsin solutions A and B (see table) were prepared from fresh ox pancreas. The pancreas was freed of fat, minced, and 200 grms. ground up in a mortar with water. In the case of preparation A, 0·1 per cent of mercuric chloride was added, and in B some thymol. The preparations were then digested in the incubator at body temperature for twenty hours.‡ Next they were filtered, and the filtrate examined for steapsin by vigorously shaking 2—3 c.c. in a test-tube with a few drops of filtered butter-fat, adding a drop of an alcoholic solution of phenolphthalein, and then decinormal caustic soda solution, till a deep red colour was obtained. Exactly the same mixture was placed into a second test-tube, the pancreatic extract having, in this case, been heated to destroy its ferments. The preparations were incubated at 37° C. After about half-an-hour the preparations were examined. In the case of the steatolytically active mixture, the contents of the test-tube were found to be discolourised, and the amount of decinormal caustic soda solution necessary to restore the original red tint was ascertained. Preparations C and D were obtained from

* A Paper read before the Royal Society, May 28th, 1903.

† Nencki ("Spaltunge der Säureester der Fettreihe und der Aromatischen Verbindungen im Organismus und durch das Pancreas," *Arch. fur Exper. Path. u. Pharmak*, vol. xx., p. 367) tested the action of an aqueous extract of pancreas on mutton fat, but found hydrolysis to proceed only to about 20 per cent. By adding bile to the digest the saponification amounted to about 60 per cent. Pawlow ("The Work of the Digestive Glands," translated by W. H. Thompson, London, 1902) also records determinations by Dr. Walther (pp. 29, 39) of the steatolytic action of pancreatic juice obtained from a fistula, but the results do not give us an estimate of the actual amount of hydrolysis effected. They were used by the workers for comparative observations.

‡ These are the methods recommended by Ferd. King ("Ueber Gasentwickelung bei Pankreasverdauung, *Pflüger's Archiv*, 1898, vol. lxx., p. 329).

200 grms. minced fresh pig pancreas by simply triturating in a mortar with twice the bulk of water. In these cases the preparations were not incubated, for it was evident that in the previous experiments with A and B the steapsin had been destroyed, as the preparations, before incubation, were very active steatolytically when tested by the above method, but only very slightly so after incubation; probably this was due to the action of trypsin on steapsin. It was also noticed in preparations A and B that the steapsin remained on the filter-paper when the solutions were filtered, the filtrates having much weaker steatolytic powers than the precipitates. Preparations C and D were, therefore, only filtered through muslin.

Preparation of the Emulsion of Fat and Steapsin.

One hundred grms. of cotton-seed oil, or lard, were weighed out and carefully triturated in a mortar with measured quantities of the pancreatic extract. Great care was taken to obtain a complete emulsion. The emulsion was then poured into bottles which were well corked to exclude growth of fungi, and allowed to stand at the ordinary temperature.* If the temperature was raised too rapidly, say by immersion in a water-bath kept at 30° or 35° C., the emulsified mass would separate into two layers, and no hydrolysis would then take place. It is therefore of the greatest importance to carefully observe the mixture for some hours, and to thoroughly shake them up as soon as signs of separation are noticed, in order to restore the state of emulsion. A good plan is to immerse the well-shaken emulsion in cold water, or to let it stand in the open during the night. After a few days, distinct hydrolysis is noticeable. In the case of cotton-seed oil, the outward sign of hydrolysis is the hardening of the mass, due to the fatty acids that have been formed.

Consideration of Results.

The accompanying table contains a series of observations made on cotton-seed oil and lard. The amount of hydrolysis was measured by the percentage of free fatty acids, expressed in terms of oleic acid. The experiments with A, B, and C were started on February 19th, and those with D on March 5th. The first observations were made after a lapse of four days. The delay was caused through some of the emulsions having separated into two layers, which necessitated the re-establishing of the state of emulsion by frequent shaking. It will be noticed that in those experiments with cotton-seed oil, in which neither acid nor alkali had been added, hydrolysis had reached after four days, in the case of preparation C, from 22·9 per cent (No. 5) to 32·8 per cent (No. 6), and in the case of preparation D, from 31 per cent (No. 11) to 37·1 per cent (No. 9). After another seven days, samples Nos. 11 and 9 had reached 46·3 per cent and 44·3 per cent respectively. As it was not expected that further hydrolysis would proceed very rapidly, some time was allowed to elapse before the next tests were taken. It will be seen from the table that the highest percentages of hydrolysis, when neither acid nor alkali was added, were 86·7 per cent in the case of preparation C (No. 6), and 83·8 per cent in the case of preparation D (No. 10). In both cases the steapsin had been allowed to act for fifty-six days. Whereas the experiments made with C show that the amount of hydrolysis increases with the amount of steapsin mixed with the oil, no such striking regularity is apparent in the case of preparations D (Nos. 9 to 11).

Further experiments were made with cotton-seed oil under the same conditions, only with that difference that either dilute acid or dilute caustic soda was added. So far, no decisive influence of either acid or alkali has been noticed, and from the experiments recorded here, no definite conclusions can be drawn.

Curiously enough, the hydrolysis of lard proceeds at a very much slower rate, reaching only about one-third of

No.	Preparation.	Cubic centimetres of preparation per 100 grms. of cotton-seed oil or lard.	Date on which started.	Added to emulsion. Acid.	Added to emulsion. Alkali.	Percentage of free fatty acids formed. Feb. 23.	March 2.	March 9.	March 16.	April 16.	May 1.
		Cotton-seed Oil.									
1.	A 1	10	19/2/03	0	0	—	—	0·95	Separation into two layers had taken place.		
2.	A 2	20	19/2/03	0·5 c.c. of 2 per cent acetic acid	0	—	0·8	"	"		
3.	A 3	16	19/2/03		0	—	1·14	"	"		
4.	B	10	19/2/03	0	0	—	0·95	"	"		
5.	C 1	20	19/2/03	0	0	22·9	43·3	48·4	80·6	"	—
6.	C 2	30	19/2/03	0	0	32·8	49·9	60·45	86·7	—	—
7.	C 3	25	19/2/03	0·5 c.c. of 2 per cent acetic acid	0·5 c.c. 1/10 normal NaOH	10·22	26·4	48·8	74·7	—	—
8.	C 4	30	19/2/03	0	0	31·25	39·5	63·1	—	—	—
9.	D 1	30	5/3/03	0	0	—	37·1	44·3	68·3	70·2	—
10.	D 2	30	5/3/03	0	0	—	32·7	46·4	71·5	83·8	—
11.	D 3	60	5/3/03	0	0	—	31·03	46·3	60·8	79·5	—
12.	D 4	60	5/3/03	0·5 c.c. of 2 per cent acetic acid	0·5 c.c. 1/10 normal NaOH	—	30·4	45·2	65·3	73·7	—
13.	D 5	60	5/3/03	0	0	—	36·5	44·9	66·4	73·5	—
14.	D 6	30	5/3/03	0	1 c.c. 1/10 normal NaOH	—	31·4	43·8	74·1	74·3	—
15.	D 7	50	5/3/03	1 c.c. of 2 per cent acetic acid	0	—	37·66	44·5	65·2	77·2	—
		Lard.									
16.	D 8	50	5/3/03	0	0·5 c.c. 1/10 normal NaOH	—	—	8·98	9·2	29·9	46·7
17.	D 9	80	5/3/03	0	1 c.c. 1/10 normal NaOH	—	—	12·3	14·4	20·7	23·9

* Most of the preparations kept free from infection during the time these experiments lasted. Only a few became covered with growth of *Penicillium glaucum* after the lapse of about four weeks.

the hydrolysis noticed in the case of cotton-seed oil. Since the consistency of lard favours the state of emulsion, one would have expected the opposite result. The last two experiments with lard seem to show that an increased amount of caustic soda, whilst favouring hydrolysis at the commencement, seems later on to retard the action of the steapsin, notwithstanding the larger amount of the latter.

The numbers recorded in the table show that the steapsin is not capable of producing the reversible reaction which it was thought, reasoning by analogy, this enzyme might produce.

These preliminary experiments are very interesting from a physiological point of view; they proved for the first time that it can be demonstrated by the usual quantitative methods of fat analysis that steapsin is a very powerful fat-splitting ferment.

We are now investigating the action of steapsin and of lipase on fats, in the presence of bile, small quantities of soaps, and a number of other substances which suggest themselves from a physiological point of view.

ON THE OPTICAL ACTIVITY OF THE NUCLEIC ACID OF THE THYMUS GLAND.*

By ARTHUR GAMGEE, M.D., LL.D., F.R.S., Emeritus Professor of Physiology in the Owens College, Victoria University, and
WALTER JONES, Ph.D., Associate Professor of Physiological Chemistry in the Johns Hopkins University.

We have lately shown the dextrorotatory character of the nucleoproteids of the pancreas, thymus, and suprarenal gland (Gamgee and Jones, "On the Nucleoproteids of the Pancreas, Thymus, and Suprarenal Gland, with especial reference to their Optical Activity," *Roy. Soc. Proc.*, 1903, vol. lxxi., p. 385). We have, in the course of our investigations, shown that the "nucleins" possess a stronger rotation than the "nucleoproteids," properly so-called, and from which they are derived, and in the researches which we have planned and which naturally are suggested by our previous work, the first step appeared to us to be to determine the optical activity of the nucleic acids corresponding to the nucleoproteids investigated by us.

In the present paper we shall confine our attention to the optical activity of thymus-nucleic acid, prepared by the method of Kossel and Neumann (*Ber.*, vol. xxvii., p. 2215). We adhered closely to the method recommended by these chemists, which furnishes with great ease a colourless product, yielding colourless and perfectly transparent solutions admirably adapted for polarimetric observations. From 6 kilogrms. of trimmed thymus, Kossel and Neumann obtained 120 grms. of pure nucleic acid. From 600 grms. of the gland, we obtained 9·5 grms., though no special pains were taken to work even in an approximately quantitative manner. Our purified product, like that of Kossel and Neumann, was free from proteid and barium.

1. An amount of nucleic acid weighing 1·109 grms. was suspended in water and dissolved by the cautious addition of dilute solution of ammonia in small quantities, so that when solution had been effected the reaction of the solution towards litmus was neutral. The volume of the solution was made up to 100 c.c. and it was then examined polarimetrically.

Weight of substance (W)	1·109 grms.
Volume of solution (V)	100 c.c.
Length of tube (L)	200 m.m.
Observed angle (α)	+3° 29′.

$$[\alpha]_D = +156{\cdot}9°.$$

2. Ten c.c. of the above neutral solution were diluted with 10 c.c. of distilled water, and the resulting solution was examined polarimetrically.

W = 1·109 grms.; V = 200 c.c; L = 200 m.m.; α = 1° 43′.

$$[\alpha]_D = +154{\cdot}2°.$$

3. Ten c.c. of the solution used in the last experiment were further diluted with 10 c.c. of distilled water and the resulting solution was examined.

W = 1·109 grms.; V = 400 c.c.; L = 200 m.m.; α = +0° 52′.

$$[\alpha]_D = +156{\cdot}4°.$$

The above observations indicate that solutions of the nucleic acid of the thymus are powerfully dextro-rotatory, but that the specific rotation of neutral solutions does not vary appreciably with dilution, the variations in the results of the three sets of observations recorded above falling within the probable limits of error. Similar results had already been obtained with solutions of the nucleoproteid of the pancreas, although the limits of dilution in that case were not so great as in the present instance.

On the Influence of the Reaction of the Solution on the Optical Activity of the Nucleic Acid of the Thymus Gland.

The observations about to be referred to indicate a very remarkable influence exerted by the reaction of the solution on the optical activity of the nucleic acid under discussion. The rotation is notably influenced by the acidity of the solution; it reaches a maximum at a certain degree of acidity and then decreases. On the other hand, the addition of ammonia in sufficient proportion will render a solution of thymus-nucleic acid optically inactive, though neutralisation of the acid will restore its pristine activity. It is to be noted, however, that there is no abrupt change around the neutral point, a statement which is illustrated by the fact that two solutions of equal concentration may be prepared which are indistinguishable in so far as their optical rotation is concerned, one of which is faintly, though distinctly, acid to litmus, while the other is alkaline.

4. Twenty-five c.c. of the original neutral solution of nucleic acid employed in the first set of experiments were made decidedly acid by the addition of a trace of 20 per cent acetic acid. The change of volume was so small as to be negligible. The solution was then subjected to polarimetric examination, with the following results:—

W = 1·109 grms.; V = 100 c.c.; L = 200 m.m.; α = +3° 30′.

$$[\alpha]_D = +157{\cdot}8°.$$

5. Twenty-five c.c. of the original solution were correspondingly made distinctly alkaline with ammonia and polarimetrically examined:—

W = 1·109 grms.; V = 100 c.c.; L = 200 m.m.; α = +3° 31′.

$$[\alpha]_D = +158{\cdot}7°.$$

The two above sets of experiments show that determinations of the optical activity of thymus nucleic acid may be made in a neutral or quasi-neutral fluid, without fear of variation caused by inaccuracy in observing the point of exact neutrality. The following experiments, however, demonstrate that the rotation is markedly changed by the addition to a neutral solution of thymo-nucleic acid either of a considerable amount of acetic acid or of ammonia.

6. Twenty c.c. of the original solution were treated with one-tenth of a c.c. of 20 per cent acetic acid and the solution was polarimetrically examined:—

W = 1·109 grms.; V = 100·5 c.c.; L = 200 m.m.; α = +3° 33′.

$$[\alpha]_D = +160{\cdot}4°.$$

7. Ten c.c. of the solution used in 6 were treated with 0·3 c.c. of 20 per cent acetic acid and polarimetrically examined:—

W = 1·109 grms.; V = 101·5 c.c.; L = 200 m.m.; α = +3° 36′.

$$[\alpha]_D = +164{\cdot}7°.$$

Up to this point we observe an increase in the specific rotation of the nucleic acid. If, however, as in the two

* A Paper read before the Royal Society, May 28th, 1903.

following experiments, the amount of acetic acid is increased the optical rotation undergoes diminution.

8. Ten c.c. of the original solution were treated with 1 c.c. of 20 per cent acetic acid and then polarimetrically examined:—

W = 1·109 grms.; V = 110 c.c.; L = 200 m.m.; α = +2° 29'.
$[\alpha]_D$ = +123°.

The remarkable influence of solution of ammonia is illustrated by the following observations:—

9. Twenty c.c. of the solution which had been used in observation 5 were treated with 0·5 c.c. of 10 per cent solution of ammonia and polarimetrically examined:—

W = 1·109 grms.; V = 102·5 c.c.; L = 200 m.m.; α = +2° 40'.
$[\alpha]_D$ = +123·4°.

10. The solution used in Experiment 9 was treated with an equal volume of 10 per cent ammonia and the resulting solution examined:—

W = 1·109 grms.; V = 205 c.c.; L = 200 m.m.; α = +0° 35'.
$[\alpha]_D$ = +50·8°.

11. The solution used in Experiment 10 was further diluted with an equal volume of 10 per cent ammonia, when the solution was found to be optically inactive.

Our observations have shown us, as has been mentioned at an earlier part of this paper, that the diminution or abolition of optical activity which is induced by alkalis in solutions of thyme-nucleic acid are not permanent, the addition of acid restoring the primitive optical condition.

Bülow ("Ueber aschefreies Eiweiss," *Pflüger's Archiv*, 1894, vol. lviii., p. 207) has shown that the optical rotation of proteids varies with changes in the reaction of their solutions, and Framm ("Untersuchungen über die specifische Drehung des β-Glutin," *Pflüger's Archiv.*, 1897, vol. lxviii., p. 144) studied especially the alteration brought about in the specific rotation of gelatin by the addition of acids or alkalis. The alterations observed by Framm, however, were probably due to fundamental chemical changes brought about by the acid or alkali on the proteid. This reasoning cannot, however, be applied to the case of the nucleic acid of the thymus gland, seeing that the addition of acid to an alkaline solution restores the optical activity.

At the suggestion of one of us (A. G.), Dr. Thomas B. Osborne has determined the optical activity of the nucleic acid which he separated from the wheat embryo, and to which he applied the name of tritico-nucleic acid (T. B. Osborne and I. F. Harris, "Die Nucleinsäure des Weizenembryos," *Zeit. f. Physiol. Chemie.*, September, 1902, vol. xxxvi., heft 2, p. 85). Dr. Osborne ("The Specific Rotation of the Nucleic Acid of the Wheat Embryo," *Amer. Journ. of Physiol*, April 1, 1903, vol. ix., No. 2, p. 69) has found that this nucleic acid is dextrorotatory, though the degree of rotation is considerably influenced by the concentration of the solution. A solution containing 4 per cent of tritico-nucleic acid possessed a specific rotation $[\alpha]_D$ = +73°.

Estimation of the Methoxyl Groups in Sulphurised Compounds.—Felix Kaufler.—Zeisel's method does not give good results with sulphurised compounds; the author has modified it, and made it applicable to the derivatives in which the methoxyl group is easily saponifiable by alkalis. The weighed substance is placed in a small flask, and heated to boiling with a solution of caustic potash. The vapours pass through a U-tube containing anhydrous sulphate of copper heated to about 90°, which absorbs the water, but allows the alcohol to pass; this latter is collected in a Winkler absorbing apparatus containing hydriodic acid, and kept very cool. The whole apparatus is traversed by a slow current of air throughout the operation. When the saponification is terminated, the hydriodic solution is heated, and the iodide of methyl is collected in nitrate of silver as in Zeisel's method.—*Mon. f. Ch.*, vol. xxii., p. 1105.

ESTIMATION AND ORGANIC ANALYSIS OF VERY SMALL QUANTITIES OF GLYCERIN.

By MAURICE NICLOUX.

Estimation.—The general method I gave first for the estimation of small quantities of alcohol has already had a number of applications. A certain number of reducible or simply oxidisable organic bodies can be estimated, when they are in very small quantities, by means of bichromate of potash and sulphuric acid, thanks to the difference of tint—a true change from bluish green to yellowish green corresponding to the absence or presence of a very slight excess of bichromate in the bluish green solution of sulphate of sesquioxide of chromium. It is in this manner that glycerin,* methylic alcohol, formic aldehyde, and formic acid in the state of purity† bear witness to this method.

I will summarise the method of estimation in so far as glycerin is concerned, and it does not differ much from that for the estimation of alcohol.

A solution is prepared of 19 grms. of pure crystallised bichromate of potash per litre, and a burette graduated to 1/10th c.c. is filled with it. Five c.c. of the liquid in which the glycerin is to be estimated is measured off and placed in a test-tube. Pure sulphuric acid at 66° B. (D_{15} = 1·842) is added in considerable excess, 5 to 7 c.c. The solution becomes very hot. The bichromate is then added very gradually, taking care to shake well, and heat carefully to boiling between each addition of bichromate, and also just at the moment when the colour changes from bluish green to a persistent yellowish green. The volume of the bichromate is then noted.

If the solutions contain more than 1 part of glycerin per 1000, which is easily detected, as more than 2 c.c. of bichromate are necessary to obtain the persistent yellowish green colour, we dilute so as to bring the proportion of glycerin below 1 grm. per litre—proportions for which the difference of tints is more easily recognised.

I have said that the volume of bichromate which gives the yellowish-green colour must be noted. It represents almost exactly the proportion of glycerin present. Consequently, strictly speaking, 5 c.c. would suffice for the estimation. In any case, to make absolutely certain, and to confirm the preceding figure, it is necessary to finish in the following manner. Repeat two experiments:—First experiment: Take 5 c.c. of the solution, add the previous amount of bichromate, less 1/10th of a cubic centimetre, then the sulphuric acid. Heat to boiling for one minute. The tube ought to be a bluish-green. Second experiment: Take 5 c.c. of the solution, add the previous volume of bichromate, then the acid. Heat as before, and the tube ought to be a yellowish-green. If this the case, the estimation is finished and the original figure is correct. If not, as may sometimes happen, and the last tube is still a bluish-green, add 1/10th c.c. of bichromate and the change to yellowish-green will take place; the figure is then 1/10th c.c. higher. With practice we can bring the estimation with two different volumes of bichromate to within 1/20th c.c.

The calculation is then extremely simple. Let *n* be the number of cubic centimetres or fractions (comprised betweed 0 and 2) indicated by the burette to obtain the yellowish-green colour; the solution of bichromate at 19 grms. per litre, is calculated in such a manner that if we operate on 5 c.c., the tint limit being the yellowish-green, we get glycerin in grammes per cubic centimetre of solution = *n*/2000 (*n* expressed in c.c.).

* It was MM. Bordas and de Raczkowsky who had the idea of applying my method for the estimation of alcohol to the estimation of glycerin. But the calculation, otherwise correct, of a false equation of oxidation had the effect of preventing them from realising it. For further details and bibliography, consult M. Nicloux, "On the Estimation of Small Quantities of Glycerin" (*Bull. Soc Chim.*, 1897, Series 3, vol. xvii., p. 455; and *Comptes Rendus de la Soc. de Biol.*, 1897, Series 10, vol iv., p. 698).

† M. Nicloux, "Estimation of Small Quantities of Methylic Alcohol, Formic Aldehyde, and Formic Acid" (*Bull. Soc. Chim.*, 1897, Series 3, vol. xvii., p. 839).

For proportions of glycerin less than 0·5 grm. per litre, it is best to dilute the 19 grm. per litre solution of bichromate, and make one of 9·5 grm. per litre; the formula then becomes:—

Glycerin in grammes per cubic centimetre of solution = $n/4000$ (n, expressed in c.c.).

To beginners especially in this method of estimation I would advise the use of six pairs of control tubes, each pair for a different, but known dilution of glycerin in water, below 1 per 1000, being for a bluish-green and a yellowish-green tube. In this manner, besides an accurate estimation, we get the exact intensity of the yellowish-green colour chosen as the limit.

The relative inherent error of this method is about 5 per cent; it may go down to 2·5 per cent, and less, in experienced hands, but it will never rise above 10 per cent even on the first time of trying.

The absolute error is about 1/20th m.grm. for proportions between 1 grm. and 0·5 grm. of glycerin per litre, and 1/40th m.grm. for proportions less than 0·5 grm. per litre.

Organic Analysis.—If we take care to work with the given amount of pure sulphuric acid, not diluted, the reaction is always identical; it corresponds to the complete oxidation of the glycerin into carbonic acid and water; the quantity of bichromate used indicates the amount, and the measurement of the carbonic acid produced will give the confirmation.

For this purpose I have devised the following arrangement:—

A tube 75 c.m. long and 2·5 c.m. diameter, closed at the bottom, and the upper end of which has been enlarged and ground, is closed hermetically by means of a glass stopper also ground.* Both surfaces are smeared with vaseline before making the joint. At about 3 c.m. from the upper end an elbow tube is sealed in, to which is fitted a length of stout rubber tube closed with a pinchcock.

Into the long tube we introduce 10, 15, 20, or 30 c.c. of pure sulphuric acid, according to circumstances (about double the volume of the glycerin solution), then carefully, a test-tube containing the solution under examination, and an amount of bichromate corresponding to the complete oxidation of the glycerin. This amount has been determined already by the method described above.

The tube is exhausted by means of a pump. A water pump will do for this first operation as the small amount of air left does not matter. The stopcock is closed, and the tube is sloped several times so as to bring the different substances into contact with each other. The reaction is completed by immersion in an oil-bath at 140°. The whole of the gas is now extracted, this time by means of a mercury pump, and collected in a graduated tube (graduated to 1/20th c.c.); a reading before and after the introduction of a little potash gives the carbonic acid by difference.

The following is a summary of one of these operations (No. 4 in the following table):—

In a test-tube we place about 10 c.c. of a solution of glycerin at 1·075 grm. per litre, or say 10·75 c.c., and 4·6 c.c. of bichromate at 19 grms. per litre (a very small excess of 0.3 c.c.), and 20 c.c. of sulphuric acid in the large tube. Close up, and pump the air out as described above. After the reaction has been allowed to take place, immerse for six minutes in the oil-bath at 140°. Extract the gas:—

Volume	16·9
KOH	8·2
CO_2	8·7

Note the pressure (H = 751) and temperature (t = 23). The weight of the carbonic acid is—

$$8{\cdot}7 \times \frac{1}{1{\cdot}0844} \times \frac{751-20{\cdot}8}{760} \times 1{\cdot}9774 = 15{\cdot}3 \text{ m.grms.}$$

* For greater security we could arrange a small cup joint filled with water, forming a hydraulic joint.

Now, the reaction $C_3H_3O_3 + O_7 = 3CO_2 + 4H_2O$ shows that 92 parts of glycerin give 132 parts of carbonic acid. Consequently, we should have CO_2 corresponding to 10·75 grms.:—

$$10{\cdot}7 \times \frac{132}{92} = 10{\cdot}75 \times \frac{33}{23} = 15{\cdot}42 \text{ m.grms.}$$

The following is the table of the results of experiments conducted in an identical manner. They show the extreme accuracy of the method.

Amount of glycerin.	Oxygen consumed.	Carbonic acid produced.	
		Theory.	Found.
M.grms.	M.grms.	M.grms.	M.grms.
8·5	10·38	12·20	12·7
16·5	20·08	23·67	23·6
10·15	12·78	15·06	15·0
10·75	13·10	15·42	15·3
5·375	6·54	7·66	7·7

We see at once the interest attached to this determination. We have done a true organic analysis: determination of the oxygen consumed and of the carbonic acid produced, by means of a very simple, rapid method, and only using a few m.grms. of material in aqueous solution.

This method, which can be further extended to the analysis of other organic compounds, will enable us, as far as glycerin in particular is concerned, to effect its identification; if we have to deal, for example, with reducing liquids containing glycerin, we can also effect the estimation of this important substance in experiments in the domain of pure chemistry and physiology. I propose to deal with this in a future paper.—*Bull. Soc. Chim.*, Series 3, vol. xxix., No. 6.

LONDON WATER SUPPLY.

Report on the Composition and Quality of Daily Samples of the Water Supplied to London for the Month Ending May 31st, 1903.

By SIR WILLIAM CROOKES, F.R.S.,
and
PROFESSOR DEWAR, F.R.S.

To Charles Perrin, Esq., M.Inst.C.E.,
Water Examiner, Metropolis Water Act, 1871.

London, June 10th, 1903.

Sir,—We submit herewith, at the request of the Directors, the results of our analyses of the 212 samples of water collected by us during the past month, at the several places and on the several days indicated, from the mains of the London Water Companies taking their supply from the Thames and Lea.

In Table I. we have recorded the analyses in detail of samples, one taken daily, from May 1st to May 30th inclusive. The purity of the water, in respect to organic matter, has been determined by the Oxygen and Combustion processes; and the results of our analyses by these methods are stated in Columns XIV. to XVIII.

We have recorded in Table II. the tint of the several samples of water as determined by the colour-meter described in previous reports.

In Table III. we have recorded the oxygen required to oxidise the organic matter in all the samples submitted to analysis.

Of the 212 samples examined by us during the month, all were found to be clear, bright, and well filtered.

The rainfall at Oxford during the month of May has been exceptionally heavy, the amount recorded being 4·38 inches; the average rainfall for May is 1·75 inches; thus we have had an excess of 2·63 inches, and this, added to the previous one of 1·72 inches, makes a total excess for the year of 4·35 inches, or 49·9 per cent on the thirty years' average.

Our bacteriological examinations of 359 samples taken during the last month have given the results recorded in the following table. Besides these samples we have ex-

amined 259 others from special wells, standpipes, &c., making a total of 618 samples in all:—

	Microbes per c.c.
New River, unfiltered (mean of 26 samples) ..	231
New River, filtered (mean of 76 samples) ..	11
Thames, unfiltered (mean of 26 samples) ..	4625
Thames-derived water, from the clear-water wells of seven Thames-derived supplies (mean of 179 samples)	19
Ditto ditto .. .. highest	128
Ditto ditto .. .. lowest	0
River Lea, unfiltered (mean of 26 samples) ..	351
River Lea, from the East London Company's clear-water wells (mean of 26 samples) ..	26

Of the 281 daily samples taken from the filter-wells of the Metropolitan Water Companies, ten samples, or 3·5 per cent, were sterile. There were seven samples, or 2·4 per cent, containing more than 100 microbes, and of these only two samples contained more than 150 microbes per c.c. The seven excess samples contained an average of 124 microbes per c.c.; in April five excess samples contained an average of 122.

From this it is satisfactory to note that in spite of the sudden and exceptional rainfall during the month of May, the bacteriological quality of the London water remains substantially as good as during the previous month, proving that adequate care has been expended and a high efficiency attained in the results of the filtration.

The exceptional rainfall at this time of the year in the watersheds of the Thames and the Lea has necessarily caused an increased amount of vegetable humus matter to pass into solution, although no more than has occurred on previous occasions at other periods of the year.

We are, Sir,
Your obedient Servants,
William Crookes.
James Dewar.

COORONGITE: A SOUTH AUSTRALIAN ELATERITE.*

By ALEX. C. CUMMING.

The name coorongite was given many years ago to a peculiar substance found as a thin superficial deposit on the soil in the Coorong district of South Australia. A small sample was recently sent to the Chemical Laboratory of the University of Melbourne, and has been examined by me, under Prof. Masson's direction, with results to be described in the sequel.

Previous Accounts.—Coorongite is briefly described by Krauss ("Mineralogy," p. 138), and by G. C. Morris (*Proc. Acad. Nat. Sci. Philadelphia*, 1877, 131), and references have been found elsewhere; but by far the best and fullest account of it that I have been able to find is contained in a paper by J. R. Jackson, published in the *Pharmaceutical Journal* of 1872 (pp. 763 and 785). From this paper it appears that coorongite had, since its discovery in 1865, excited a good deal of interest both in Australia and in England, and that the question of its true nature and probable origin had been the subject of considerable discussion. Very different views were expressed, some regarding the substance as a bituminous hydrocarbon mineral, others believing it to be of vegetable origin. These discussions of thirty years ago appear to have been forgotten, and within the last year attention has been directed afresh to the same questions, still unsettled, by newspaper accounts of quests for mineral oil in the district where coorongite occurs. Jackson's paper was not known to me till after I had done the work to be described. My results are, in the main, corroborative of those he records and quotes from other observers, but additional information has been gained as to the chemical nature of the material.

Description of Coorongite.—My specimens were in sheets varying from one-tenth to 1 c.m. in thickness. The substance varied in colour on the surface from greyish-black to black, but was uniformly black internally. It was soft, flexible, and elastic, resembling caoutchouc; one surface, probably the upper, was hard, black, and sponge-like; it contained a considerable quantity of sand and some vegetable fibres; it burnt readily with a white flame, melting before the flame, and giving, especially when extinguished, a characteristic odour, quite distinct from that from hydrocarbon minerals, and suggestive of burning animal or vegetable fats. Jackson gives the following analysis of coorongite by Dr. A. J. Bernays:—

Moisture	0·4682
Carbon	64·73
Hydrogen	11·63
Ash	1·79
Fixed carbon	1·005
Oxygen and unestimated	20·3768
	100·0000

The substance is insoluble in water and alcohol, and only partially soluble in carbon bisulphide, ether, chloroform, turpentine, benzene, and toluene, giving bright yellow solutions. This confirms observations of G. Francis, quoted by Jackson. On evaporation of the solvent a soluble body of low melting-point is obtained, the coorongite being thus separated into this body and a friable insoluble residue.

Separation into two Constituents by Extraction with Carbon Bisulphide.—100 grms. were cut up into small pieces and subjected to successive extractions with carbon bisulphide in a Soxhlet's extractor. After the first extraction the residue, which was quite friable, was rubbed to powder before adding fresh solvent. The product of each extraction was separately examined after evaporating off the carbon bisulphide. The results are shown in the following table:—

	Time of extraction. Hours.	Weight of extract. Grms.
1st Extraction	7	20·80
2nd „	12	2·78
3rd „	16	0·16
4th „	18	0·05
	53	23·79

Thus the sample yielded nearly 24 per cent of the soluble constituent. As the residue was found to contain from 30 to 40 per cent of sand and other mineral matter, the soluble constituent formed about one-third, and the insoluble constituent about two-thirds of the organic material. The results of the later extractions show that separation was complete.

The Soluble Constituent.—This is a clear, yellow, translucent, wax-like solid. Softens enough to flow if kept at 35°, and is quite fluid at 42°. Heated in an oil-bath it decomposed above 225°, yielding a little black distillate and a tar-like solid residue.

It dissolves readily, and in all proportions, in benzene, ether, toluene, chloroform, and carbon bisulphide, and is insoluble in water, methyl alcohol, and ethyl alcohol.

The composition was obtained by combustion with cupric oxide in a current of oxygen. The results agree closely with the figures calculated for the formula $C_{10}H_{18}O$.

	I.	II.	III.	Mean.	Calculated for $C_{10}H_{18}O$.
Carbon	77·86	77·94	77·92	77·91	77·92
Hydrogen	11·97	11·87	11·93	11·92	11·69
Oxygen (by diff.)	10·17	10·19	10·15	10·17	10·39

As the molecular weight could not be got by vapour density measurement, recourse was had to the freezing-point method, using benzene as solvent. The benzene

* Read before the Royal Society of Victoria, October 9th, 1902. From the *Proc. Roy. Soc. Victoria*, 1903, vol. xv., Part 2, p. 134.

used was specially purified, and had the freezing-point 5·33° cor. Ice and water were used for freezing, and five observations were made at each temperature. The constant K for the benzene was determined by experiment with naphthalene, which gave a value of 5390.

1·080 grm. of the substance dissolved in 30·0 grms. benzene lowered the freezing-point 0·080°.

Using the formula—

$$M = K \frac{S}{\Delta L}$$

where M = molecular weight, K = a constant (5390 in this case) Δ = the depression produced, and L = weight of solvent, these figures indicate a molecular weight of 2425. The formula $(C_{10}H_{18}O)_x$ requires a molecular weight of 154, or some multiple thereof; and it would therefore appear that the value of x in benzene solution is 16 (M = 2464), or, in other words, the soluble constituent of coorongite is $(C_{10}H_{18}O)_{16}$ in benzene solution.

It is well known, however, that organic oxygen derivatives of the alcohol and acid kind are given to association in benzene solution, though they have simple molecules in other solvents, and that the molecular weight of a substance in benzene solution is often twice as great as the normal.

Observations were therefore made on the boiling-point of an ether solution of the substance, using ether purified by distillation from sodium immediately before use.

The whole of the ether (about a litre) distilled at 34·2°, but the first and last portions were rejected.

The boiling-point was raised 0·100° by the addition of 1·370 grm. of the material to 24·1 grms. of the ether, which by the formula—

$$M = K \frac{S}{\Delta L}$$

where K for ether = 2100, S and Δ have values given above, and L = 23·9 (allowing for vapour, &c.), gives the approximate value 1204 for the molecular weight, which is, within the error of experiment, half the value obtained in benzene solution. In these experiments, Beckmann's freezing-point and boiling-point apparatus were used with thermometers divided into hundredths of one degree C., and capable of being read by eye to 0·002°.

The results obtained indicate that the soluble constituent of coorongite is $(C_{10}H_{18}O)_x$, and that $x = 8$ in ethereal solution and 16 in benzene solution; x may, of course, have other values under other conditions.

Only an incomplete examination of the chemical properties of this substance has been made as yet. It is unacted on by acids except strong H_2SO_4, which chars it.

It combines with bromine, forming a black, viscous, sticky, semi-solid, readily soluble in carbon bisulphide and ether, but which has not yet been investigated.

It oxidises readily, as will be shown later. Attempts to saponify it led to negative results, though it is stated by Jackson to be saponifiable.

The Insoluble Constituent.—This was rubbed to a coarse powder during the extraction, and resembled brown cork filings mixed with much sand. Practically all the elasticity is lost during the carbon bisulphide extraction; it is combustible, burning with a white luminous flame, and melting before the flame; when burning it gives the same odour, like that of a burning fat, which coorongite itself gives. Analysis by combustion gave the following results for the organic matter:—

	I.	II.	Mean.	Calculated for $C_{10}H_{20}O_3$.
Carbon	64·16	64·28	64·22	63·83
Hydrogen	10·54	10·50	10·52	10 64
Oxygen (by diff.) ..	25·30	25·22	25·26	25·53
	100·00	100 00	100·00	100·00

The amount of ash (principally sand) varied from 30 to 40 per cent. The figures for the organic part agree remarkably well with those calculated for $C_{10}H_{20}O_3$, seeing that the material has undergone no purification other than the treatment with carbon bisulphide. Its dark colour suggests that it contains traces of some more highly carbonaceous material, which would account for the slight discrepancy.

This constituent, unlike the soluble one, was found to be saponifiable by hot alcoholic caustic potash, a soluble soap being obtained which yielded an insoluble fatty body on treatment with acid. This action has not yet been further examined.

Intermediate Oxidation Products.—The similarity of the formulæ $C_{10}H_{18}O$ and $C_{10}H_{20}O_3$ suggest that the insoluble ingredient is derived from the soluble one by a natural change involving hydration and oxidation combined.

Observations made in the course of the examination tended to confirm this, and to show that changes of this nature are readily brought about. In the following table are given the results of the combustions of three products obtained from portions of the soluble extract. No I. was got by blowing air through the carbon bisulphide solution; No. II. was formed during an attempt to extract some of the substance with methyl alcohol; No. III. was obtained when trying to distil it in steam. They were separated as completely as possible from unaltered substances by centrifuging the mixture at a temperature high enough to keep the latter in a molten condition. These three substances had the appearance of the clear first constituent of the coorongite, but containing an opaque, yellowish, granular precipitate. They could not be separated by solubility in carbon bisulphide or ether, but a partial separation was effected by centrifuging.

For comparison, the mean results of the combustions of the soluble and insoluble constituents and the calculated values are again given. It is evident from the table that products I., II., and III. are incompletely oxidised mixtures.

	C.	H.	O (by diff.).
Calculated for $C_{10}H_{18}O$ ..	77·92	11·69	10 39
Soluble constituent	77·91	11·92	10·17
Product No. II.	71·87	11·11	17·02
Product No. I.	70·35	11·42	18·23
Product No. III.	66·46	10·71	22·83
Insoluble constituent ..	64·22	10·52	25·26
Calculated for $C_{10}H_{20}O_3$ ..	63·83	10·64	25·53

The Ash.—The ash comprised about 25 per cent of the sample on which this work was done, but in a later specimen, since obtained from R. H. Walcott, Esq., F.G.S., of the National Museum, only 5·4 per cent of ash was found. The analysis failed to show the presence of any phosphates, which would be expected if the coorongite were of animal origin. The ash had the following composition:—

Silica	95·12
Aluminium and iron oxides	3·66
Calcium oxide	1·17
Sodium chloride	trace
	99·95

Mr. D. J. Mahony kindly examined the mineral part of coorongite, and found a number of species of typical freshwater diatoms. Only a small part consisted of diatoms, the ash being mostly sand, and it is doubtful whether the occurrence of these diatoms is more than accidental.

Conclusions.—Coorongite has been shown to consist of two substances: one with the formula $(C_{10}H_{18}O)_8$, and the other $(C_{10}H_{20}O_3)_y$. The physical properties of the substance have earned it the name of Mineral Caoutchouc, and these formulæ favour the idea that it is really related to caoutchouc, which has the formula $(C_{10}H_{16})_x$. Caoutchouc oxidises readily, even taking up oxygen from the air, and some of the substances connected with it and with gutta-percha have compositions and properties very similar to those of the two constituents of coorongite. The formulæ for these constituents are readily derivable from $C_{10}H_{16}$ by oxidation and hydration. However, for

the present the nature of coorongite must still be considered an open question, as much remains to be done in the further chemical investigation of its constituents.

BIBLIOGRAPHY OF COORONGITE.

1862. Phipson, T. L. (*Geologist*, vol. v., p. 141).
1866-7. Ulrich, G. H. F. ("Official Record of Intercolonial Exhibition," pp. 91 and 168).
1872. Jackson, J. R. (*The Pharmaceutical Journal and Transactions*, pp. 763 and 785).
1877. Morris, G. C. (*Proc, Acad. Nat. Sciences*, Philadelphia, p. 131).
1892. Dana, J. D. ("System of Mineralogy," p. 1019).
1889. Roscoe and Schorlemmer ("Treatise on Chemistry," vol. iii., Part 5, p. 498).
1896. Krauté, F. M. ("Introduction to the Study of Mineralogy for Australian Readers," p. 138).
1896. Chester, A. H. ("Dictionary of Names of Minerals," p. 64).
1902. "Petroleum Prospecting in South Australia," *The Argus*, Melbourne, June 23rd, p. 8.

PROCEEDINGS OF SOCIETIES.

THE ROYAL SOCIETY.

CONVERSAZIONE AT BURLINGTON HOUSE.

THE Annual "Ladies' Night" at the Royal Society was held on Friday evening last, June 19th, and was attended by a numerous and distinguished company. The guests were received by the President, Sir William Huggins, O.M., &c., and Lady Huggins, and the members of the Council.

A certain number of the exhibits had been shown at the previous Soirée in May; among these were Sir Oliver Lodge's New Coherer for Wireless Telegraphy, Prof. Trouton's Meteorological Instruments, Drs. Anderson and Flett's Photographs and Specimens illustrating the late Eruptions in St. Vincent and Martinique, Sir William Crookes's "Spinthariscope," and experiments illustrative of some of the Properties of the Emanations from Radium, and these have been already dealt with in our columns.

Among the new exhibits we may mention that by Dr. O. J. SILBERRAD, on the Detonation of Small Shells; this comprised:—1. Common Lyddite shells illustrative of incomplete, and of successful detonation of Lyddite. 2. Armour-piercing Lyddite shells, showing complete detonation, and also the effect of supporting the shells in steel plates. 3. The obturator of a closed vessel which has been pierced by fragments of a tin case in which a high explosive was detonated; lent by the kindness of Sir Andrew Noble, F.R.S. 4. Photographs showing shell detonating, and also showing the destruction of a 15 pr. B.L. gun by the detonation of a 12 pr. Lyddite shell (charge, 1 lb. 9½ ozs. Lyddite).

Mr. F. ENOCK, F.L.S., showed some Colour Photographs of Living Insects to illustrate Protective Colouration and Resemblance. These were taken by the three-colour process from *living* insects.

Mr. HENRY CROOKES, F.C.S., exhibited a number of plate cultures and photographs illustrative of the Bactericidal Properties of the Emanations from Radium. Various cultures of bacteria were exposed to the action of 10 milligrms. of bromide of radium, through a mica screen, at about one inch distance from the surface of the plate. After having been subjected to the action of the radium emanations, "electrons" in these cases, the plates were incubated for twenty-four, forty-eight, or more hours. In every case it was found that the microbes were killed where they had been exposed to the radium, so that, on incubation, a bare space, free from bacterial growth, was left on the plate opposite the point where the radium had been placed. Among the bacteria experimented with were *B. liquefaciens*, *B. coli communis*, *B. prodigiosus*, &c.

The Rev. JOHN M. BACON's Aërial Photographs were very interesting. They were obtained recently from balloons under unique circumstances. They comprise pictures taken during the transit of the Irish Sea by sky from the Isle of Man to Dumfries, demonstrating the sea bottom at a depth of ten fathoms photographed from an altitude of 600 feet; views of London from aloft; cloud-land above the city, and other views.

Mr. CHARLES BAKER showed a New Turbidimeter, for determining the Turbidity of Water. This instrument, designed by Mr. C. Anthony, jun., F.R.A.S., consists of two parallel tubes, one of which, of a standard length, closed at the ends by plates of glass, contains the water to be examined, and the other a Nicol prism. These two sources of light are examined through an eye-piece containing another Nicol prism, and by employing a rectangular prism between the eye-piece and the two tubes, the field of view is seen neatly dechroitomised, one half being illuminated by light coming through the tube containing the water under examination, whilst the other half receives light from the tube containing the Nicol prism. By rotating the eye-piece the illumination of the latter half of the field, seeing that the light has already passed through a Nicol prism, can be varied until it matches the half receiving the light through the standard thickness of water under examination. The amount of turbidity of the water can be read off to a rational scale, in which "I" represents perfect transparency, and "O" total obscuration.

The Marine Biological Association's exhibit always attracts attention; on this occasion it dealt with the Migration of Plaice in the North Sea; a new British species of the Polychæte family Sabellaridæ; and a number of living specimens of the Plymouth marine fauna.

The Condensation of the Radio-active Emanations of Radium and Thorium by Liquid Air was shown by Prof. E. RUTHERFORD, F.R.S., and Mr. F. SODDY. The radio-active emanations of thorium and radium appear to be the residues of the thorium atom and radium atom respectively after the heavy positively charged particles, known as the "rays," have been projected. They have all the properties of inert gases of the argon family, and diffuse away from the radium and thorium compounds producing them. They can be condensed at the temperature of liquid air, and are again volatilised on raising the temperature. Their actual quantity is almost infinitesimally small, being quite invisible and unweighable, but their presence can be detected by their property of radio-activity.

Prof. ERNEST WILSON exhibited the Cooper-Hewitt Mercury Vapour Lamp. The light, though almost entirely lacking in red rays, and therefore producing a considerable distortion in colour values, is for many purposes greatly superior to the ordinary electric light. The absence of red, well known as the colour most exciting and fatiguing to the eye, makes the light an almost ideal one for work where an absolute comparison of true colour values is not required. One of the greatest fields of application of the lamp is for all sorts of photographic purposes. The efficiency of the light is about ½ watt per spherical candle-power, and under favourable circumstances as high as 0·3 watt per candle-power, being about seven times that of the ordinary electric glow lamp.

Two demonstrations with Lantern and other illustrations were given during the evening in the Meeting Room; the first by Prof. E. B. POULTON, F.R.S., on the discoveries of Mr. Guy A. K. Marshall upon the wet season and dry season forms of Rhodesian Butterflies; and the second by the Bioscope Company, who showed, among other interesting subjects, "living pictures" of battling with mountainous waves in Mid-Atlantic, Yellowstone Waterfalls, great tidal wave, "The Bore," sweeping up the Severn, and logging in Canada.

PHYSICAL SOCIETY.

Ordinary Meeting, June 12th, 1903.

Dr. R. T. GLAZEBROOK, F.R.S., President, in the Chair.

PROF. S. P. THOMPSON showed Some Experiments on Shadows in an Astigmatic Beam of Light.

Two years ago Prof. Thompson showed before the Society some experiments on the shadows formed when a thin rod is placed in a beam of light which has passed through a tilted plano-convex lens. In those experiments the peculiar effects were chiefly due to the aberration known as coma. Following up his experiments, Prof. Thompson has investigated the shadows produced when a thin rod is placed in an astigmatic beam. The results are complicated by spherical or central aberration, which is generally present in the beam. The first experiments showed the effect of this aberration upon the shadow of a thin rod. A beam of light was passed through an ordinary convex lens and allowed to fall upon a semi-transparent screen. When the object was placed vertically so as to pass through the axis of the pencil anywhere between the foci formed by the central portion of the lens and the extreme zones, the shadow cast upon the screen was seen to be a vertical line passing through the centre of an oval. The oval is formed by the rod cutting out of the beam, the whole of the light from the zone of the lens which has its focus at the point upon the axis at which the rod is placed. The thickness of the rod determines the width of the zone and the consequent width of the oval shadow. Experiments were then shown, using an astigmatic beam with as little central aberration as possible. If the rod is placed at an angle of 45° to the vertical and passes through the axis of the pencil, then when it is either close to the lens or close to the screen the shadow makes an angle of 45° with the vertical also. As the wire moves from the screen to the lens the shadow turns over, 90° of the rotation taking place when passing from one focal line to the other. When the rod passes through the horizontal focal line, it cuts off the light from a thin vertical slice of the lens, and the shadow is therefore vertical. When it passes through the vertical line, the light is cut off from a horizontal slice of the lens, and the shadow is horizontal. When a thin rod inclined at 45° to the vertical is placed in a beam possessing both spherical and astigmatic aberrations, the shadow produced is a straight line when the rod is in contact with the lens or the screen. As the rod moves from one position to the other, the shadow turns over. It is also distorted in the process, so that its general shape is like the letter S. Prof. Thompson gave a simple formula for finding the inclination of the shadow of a rod when placed at any point on the axis of an astigmatic beam.

Prof. J. D. EVERETT expressed his interest in the subject. He said the experiments were very neat and the explanations clear. Assuming that the focal lines are at right angles, he indicated a simple method of determining the rotation of the shadow of a rod in an astigmatic beam. The formula arrived at was very similar to that given by Prof. Thompson.

Mr. SOWTER said he was pleased to see Prof. Everett now agreeing with the assumptions which were embodied in his (Mr. Sowter's) paper on "Astigmatic Aberration," read before the Society last December. Prof. Everett had also verified some mathematical points brought out in that paper. It was unnecessary to prove that the section of the astigmatic beam was elliptical, for it has been known to be an ellipse in standard astigmatic pencils for the last fifty years. In the paper mentioned, it is shown that by reference to the elliptic sections any ray of the beam is defined by a constant eccentric angle, that the shadows or images on the picture screen are merely rotated or displaced in a pure beam, a rotation of 90° occurring between the focal lines, but that the shadows are distorted when spherical aberration is present in the lens system producing the beam.

A paper by Prof. F. T. TROUTON and Mr. E. S. ANDREWS, "*On a Method of Determining the Viscosity of Pitch-like Solids*," was read by Prof. TROUTON.

The various methods which have been proposed for measuring viscosity meet with difficulties when it is attempted to apply them for the measurement of the viscosity of bodies such as pitch. To obviate some of these difficulties a method has been devised in which a constant torque is applied to a cylinder of the substance, and the relative rate of rotation of the ends is observed. From these and the dimensions of the cylinder, the viscosity can be calculated by means of a formula deduced in the paper. The apparatus consists of a shaft turning freely on roller bearings with a pully attached, from which weights may be hung for the purpose of applying the constant torque. The shaft carries a square socket for the purpose of gripping the squared end of the cylinder of the substance used. The other end of the cylinder is held in a fixed socket, and the shaft and pulley carry a divided circle to enable the rate of rotation to be observed. The apparatus can easily be arranged for carrying out observations at different temperatures. Two new effects were at once observed:—(1) The coefficient of viscosity of bodies, such as pitch, is a function of the time; and (2) on removing the stress there is a flow back in the opposite direction which gradually diminishes to zero with time. These facts were illustrated by means of curves derived from experiments on a sample of "British pitch." On first applying the torque there is a rapid flow which gradually diminishes, and finally reaches a steady state. On removing the turning-couple the cylinder turns back some little distance, at first rapidly, then slowing down gradually to rest. In the initial stage a store of elastic energy is gradually accumulating which is preserved intact during the steady rotation, and given out on removal of the stress to produce the return flow. The rate of dissipation of the strain-energy stored in a cylinder of pitch when in a steady state of rotation, was determined by gradually removing the weights producing the torque at such a rate as to prohibit rotation in either direction. The fact that the strain energy disappears without any deformation occurring enables us to draw a distinct line between plastic and viscous substances. In a plastic substance, when held under deformation, the strain-energy does not lessen with time, while in a viscous substance it is dissipated. The apparatus was used for experiments on pitch, sodium stearate, and glass at high temperatures, and also to verify the formula employed.

Mr. ROLLO APPLEYARD said that with materials such as Prof. Trouton had investigated, it was necessary to exercise great care in eliminating errors due to slip and other disturbances at the ends of the bars. For this reason it was, as a rule, better to attach the rotating-index pointer not to the clamp which applies the twist, but at a place at a little distance along the bar itself. A convenient way of doing this with these comparatively weak materials was to slip an indiarubber ring over the bar. Between this ring and the bar could then be held a piece of cork carrying a pointer. Instead of applying separate weights to a scale-pan in such tests, it led to smoother results if the weights were increased by the flow of water into a vessel. Mr. Appleyard thought that it was almost hopeless to seek for mechanical "constants" in respect to such highly extensible and complex substances as pitch, and suggested that for such materials, and perhaps for materials in general, it might be better to assume that the ratio of strain to stress is a function, possibly a logarithmic function, of the stress. The investigation of this function from small displacements right up to the breaking strain, would be more useful than figures based upon the assumed constancy of Young's modulus and Poisson's ratio.

Prof. TROUTON, in reply to Mr. Appleyard, said that the rapid flow on first applying the torque was not due to any end effect, but was a property of the material. He also mentioned that he had determined the viscosity of shoe-

makers' wax by Stokes's method. A leaden bullet is allowed to fall through a tube filled with the wax, and from its rate of descent the viscosity can be calculated. The difficulty of following exactly the motion of the bullet can be overcome by using Röntgen rays. The results obtained from these experiments agreed very well with those obtained from the apparatus described in the paper.

A paper by Mr. O. W. Richardson, on "*The Positive Ionisation produced by Hot Platinum in Air at Low Pressures*," was taken as read.

The experiments described in this paper were almost all made at temperatures so low that there was no appreciable negative ionisation. In examining the relation between the current from a positively charged hot platinum wire and the applied E.M.F. at low pressures, results were obtained which indicated that the value of the current fell off with time when the other conditions were kept constant. Further experiments showed that the current died away rapidly at first until it reached a steady value which only disappeared gradually. Calling this steady value of the current C_0, it is found that the value C at any time t is given by $C - C_0 = Ae^{-kt}$, where A and k are constants. It is shown that this is the form which would be obtained if the induced leak $C - C_0$ were produced by the monomolecular decomposition of some substance which gave rise to positive ions. The rest of the paper deals with the methods by which a wire which has lost the power of producing positive ionisation may have that power restored to it. It is shown that this can be done (1) by charging it negatively and allowing it to receive the positive ionisation from a fresh hot wire, (2) by exposing it to air for some time, and (3) by placing it in a vacuum-tube in which a luminous discharge is taking place. Experiments illustrating the nature, and determining the magnitude, of each of these effects are described.

THE TOKYO CHEMICAL SOCIETY.

The Tokyo Chemical Society celebrated its Twenty-fifth Anniversary on May 9th, 1903, under the Presidency of Prof. Joji Sakurai, LL.D. There were present Baron D. Kikuchi, the Minister of Education; Baron H. Kato, the President of the Tokyo Academy of Sciences; Dr. K. Yamakawa and Dr. A. Hamao, the President and Ex-President of the Tokyo Imperial University; Prof. K. Mitsukuri, the President of the Zoological Society; Prof. N. Nagai, the President of the Pharmaceutical Society; Prof. F. Omori, the President of the Mathematical-Physical Society; Prof. K. Miura, the President of the Medical Society; and Prof. Oscar Loew, besides members and associates of the Society, numbering about seventy in all.

After the reports of the previous year by the retiring President, the Treasurer, and the International Atomic Weight Committee were presented and adopted, and two papers by Prof. M. Kuhara, of the Kyoto University, were read, the President gave an address on the history of the Society since its foundation in 1878, according to which the Society is making a very fair progress both in numerical strength and in the nature and quality of the papers communicated. Announcement was then made by the President that Robert William Atkinson, Esq., B.Sc., of Cardiff, Dr. Edward Divers, F.R.S., of London, Dr. Oscar Kellner, of Möckern, and Dr. Oscar Loew, of Tokyo, were elected to the Honorary Members of the Society. This was followed by an interesting paper by Prof. K. Ikeda on the development of chemical science in Japan, and by an elaborate paper by Prof. T. Takamatsu on the progress of chemistry in general within the last twenty-five years. Congratulatory addresses were then delivered by the Minister of Education and the President of the University, after which the members and the guests went over the exhibits of the objects of chemical interest, which were contributed by various chemical institutions in Tokyo.

In the evening the members and the guests sat together at dinner, again under the presidency of Prof. Joji Sakurai. After the health of the Emperor was most enthusiastically honoured, the President, in proposing the toast of the Honorary Members, spoke as follows in English:—

"Your Excellency and Gentlemen,—It is now my pleasant task to propose a toast, which has a peculiar importance, and which, I am sure, you will all drink with utmost enthusiasm. It is the toast of the Honorary Members of the Tokyo Chemical Society. The election to the Honorary Members of the Society, for the first time in the history of its existence, of four gentlemen—Mr. R. W. Atkinson, Dr. Edward Divers, Dr. Oscar Kellner, and Dr. Oscar Loew—distinguished alike for their scientific attainments and for the important parts they have played in the progress of chemistry in this country, has been, I assure you, one of the most pleasant functions in connection with the celebration of this jubilee. The names of these gentlemen are so familiar to us and their work so well known to the scientific world that any eulogy upon them would be perfectly superfluous, but I cannot let the occasion pass without expressing my deep-rooted conviction that, had it not been for their constant and untiring endeavour to encourage the study of science for its own sake, chemistry in this country would never have attained the position which it now holds. Although, gentlemen, Mr. Atkinson, Dr. Divers, and Dr. Kellner have already left us, it is my sincere hope that they may some day come back to our shores to see that the seeds they have planted are growing into trees and bearing fruit. At the same time, it is a source of intense pleasure to think that Dr. Loew is among us, ever active with the prosecution of research, and ever ready to lend his helping hands to those who would come to him for advice and counsel. I have now the pleasure of giving you, gentlemen, the toast of the Honorary Members, coupled with the name of Dr. Loew."

Dr. Loew briefly replied in English.

The other toasts were "The Guests," proposed by Prof. Takamatsu, and replied to by the Minister of Education; "The Learned Societies," proposed by Prof. Matsui, and replied to by the President of the Tokyo Academy of Sciences; and "The Tokyo Chemical Society," proposed by Dr. Hamao, and replied to by the President.

NOTICES OF BOOKS.

Die Konstitution des Kamphers und seiner wichtigsten Derivate. ("The Constitution of Camphor and its most Important Derivatives"). By Ossian Aschan. Braunschweig: Friedrich Viewig und Sohn. 1903.

This book is a short monograph on the advances which have recently been made in our knowledge of the constitution of camphor and its derivatives. The concise and handy way in which the information is summarised will render the book useful, not only to those who devote themselves to the study of camphor, but also to all investigators of alicyclic compounds. The Bredt formula is adopted throughout the book as that which is most probably correct and least open to objections, though its claims to accuracy are not unfairly emphasised, an instance of the somewhat unusually unbiassed character of the monograph. A large portion of the book is devoted to the discussion and examination at considerable length of the different camphor formulæ which have been suggested, and the interesting manner in which this portion of the book is written is likely to give the reader an intelligent grasp of the difficulties to be overcome and the methods of attack to be adopted in dealing with problems of this class. If it does not make too great demands upon his time, the student can hardly follow any more in-

structive method of acquiring the power of making original investigations in the region of organic chemistry than that of studying the researches which have led up to the discovery of the constitutional formula of a substance such as camphor.

Beiträge zur Chemischen Physiologie und Pathologie. ("Contributions to Chemical Physiology and Pathology"). Edited by Franz Hofmeister. Band III. 9 and 10 Heft. Braunschweig: Friedrich Viewig und Sohn. 1903.

The history of the discovery of a hitherto unknown product of pancreatic auto-digestion is contained in this issue of these *Beiträge*. This substance, for which the name skatosine has been suggested from its apparently close relationship to skatole, was first isolated by Dr. Fritz Baum in 1899, and has since been subjected to further investigations at the Physiological-Chemical Institute at Strassburg. The results of these investigations are described, and additional information given in a paper by R. E. Swain. The formula of skatosine is $C_{10}H_{16}N_2O_2$, and it appears to stand in close relationship to the indol group of the albumen molecule, though it does not contain the indol residue as such. Among other papers of interest in this number are a preliminary communication describing still unfinished researches dealing with the proteolytic enzyme of yeast, and a short paper by Dr. Martin Jacoby on the question of the specific action of the intracellular ferments.

Berichte über Land- und Forstwirthschaft in Deutsch-Ostafrika. ("Reports on Agriculture and Forestry in German East Africa"). Band I. 3-5 Heft. Herausgegeben vom Kaiserlichen Gouvernement von Deutsch-Ostafrika. Heidelburg: Carl Winter's Universitäts Buchhandlung. 1903.

These three issues of the Government Reports of the Colonial Department of the Foreign Office on matters relating to agriculture and forestry are chiefly occupied with questions of biological interest. The reports have been carefully compiled, and the details to be found in them will no doubt be of use to those interested in these subjects. Statistics and descriptions are given as to the results of experiments in the cultivation of various crops in different parts of German East Africa, with, in some cases, reports on the analyses of the soils in various districts. Part 5 contains a short criticism of Dr. Wohltmann's essay on "The Prospects of Coffee Cultivation in the Mountains of Usambara," which was published in *Tropenpflanzer* in 1902, and in which, according to the author of this criticism, Dr. A. Zimmermann, the views expressed were more pessimistic than is warranted by facts.

CORRESPONDENCE.

THE RUSTING OF IRON.

To the Editor of the Chemical News.

Sir,—In an interesting paper by Prof. Dunstan recently transcribed into the Chemical News (vol. lxxxvii., p. 270) the causes of the rusting of iron are dealt with in some detail. Various facts are established or confirmed, and the composition of the rust is stated. In this last phase of the question Prof. Dunstan appears to have overlooked the fact that all ordinary rust contains ferrous iron and is magnetic. It follows that the formula which he suggests, $FeO_2(OH)_2$, cannot be accepted as general.—I am, &c.,

Bertram Blount.

76 & 78, York Street, Westminster, London, S.W., June 16, 1903.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Note.—All degrees of temperature are Centigrade unless otherwise expressed.

Comptes Rendus Hebdomadaires des Séances, de l'Académie des Sciences. Vol. cxxxvi., No. 21, May 25, 1903.

Action of Acetylene on Cæsium-ammonium and Rubidium-ammonium. Preparation and Properties of the Acetylenic Acetylides, C_2Cs_2, C_2H_2—C_2Rb_2, C_2H_2, and the Carbides of Cæsium and Rubidium.—Henri Moissan.—Cæsium and rubidium form carbides of formula C_2R_2 and acetylenic acetylides, C_2R_2. C_2H_2, comparable with the same derivatives of the other alkaline metals. These new carbides decompose cold water, giving an alkali, with evolution of pure acetylene gas. They are in all respects similar to calcium carbide. They are very energetic reducing agents, combining in the cold with non-metals, with production of heat, and they easily decompose oxides below red heat. The acetylenic acetylides are explosive bodies, which, during the phenomena of reduction, cause violent reactions.

Combined Hydrogen contained in Reduced Copper.—Anatole Leduc.—This paper is in answer to a remark at the end of M. Armand Gautier's communication of January 5, 1903, on the subject of atmospheric hydrogen.

Decomposition of Lithium Carbonate by Heat.—P. Lebeau.—Under the action of heat lithium carbonate begins to decompose at about 600°, and even at this temperature the oxide has a vapour-tension which shows that it can be completely vaporised. A list of the vapour-tensions at temperatures varying from 580—1000° is given.

Electrolysis of Barium Sulphide with a Diaphragm.—André Brochet and Georges Ranson.—This research is a continuation of a previous one on the electrolysis of barium sulphide without a diaphragm. If a porous pot is used to separate the two poles, the primary reaction is the same; that is to say, sulphur—and, consequently, polysulphides—are obtained at the anode, barium—and, consequently, baryta and hydrogen—at the cathode. With a diaphragm there is no reduction of the polysulphides. On the other hand, the baryta which diffuses into the anode compartment being, under the conditions of the operation, without action on the very soluble polysulphides, can be separated and collected. The yield is practically the theoretical one.

Method of Decomposition of Mixed Organo-magnesium Compounds.—V. Grignard.—In the numerous synthetic reactions effected by means of mixed organo-magnesium compounds of formula R,MgX, it is always noticed that the compounds split in the same manner in the two monovalent groups, R and MgX. A single exception to this rule was noticed by M. Blaise, who found that, with ethylene oxide and C_2H_5MgBr, the reaction was $C_2H_5MgBr + \begin{matrix}CH_2\\|\\CH_2\end{matrix}\!\!>\!O = \begin{matrix}CH_2—C_2H_5\\|\\CH_2—OMgBr\end{matrix}$. The author investigates this seeming exception, and succeeds in bringing this reaction in conformity with the general rule.

Acetones of Acetylenic Function. New Method of Synthesis of Pyrazols.—Ch. Moureu and M. Brachin.—The acetylenic acetones, $R—C\equiv C—CO—R'$, when reacting on the hydrazines give pyrazols. This new method of synthesis enables the authors to fix in a certain manner the constitution of pyrazols prepared with the non-symmetric β-diketones.

Certain Addition Products of Vinylacetic Acid.—R. Lespieau.—The isomerism of the crotonic and isocrotonic acids has been interpreted in two ways—(1) That isocrotonic acid is only vinylacetic acid, $CH_2=CH—CH_2—CO_2H$; and (2) that it is a stereo-

isomer of crotonic acid corresponding to the formula $CH_3—CH=CH—CO_2H$. The question as to the real constitution is still uncertain. The author investigates the question by obtaining the acids $CH_2Cl—CHCl—CH_2—CO_2H$ and $CH_2Br—CHBr—CH_2—CO_2H$.

Electrolytic Separation (1) of Manganese from Iron, (2) of Aluminium from Iron or Nickel, (3) of Zinc from Iron.—MM. Holland and Bertiaux.—The separation of manganese from iron can be effected electrolytically, the manganese being precipitated in the state of peroxide on the anode and the iron on the cathode. The authors overcome the practical difficulties connected with this separation. To separate iron from aluminium the metals must be in the form of sulphate to which ammonium citrate and SO_2 are added. When iron is separated from zinc electrolytically, the iron, by the addition of SO_2, passes into the form of ferrocyanide of potassium.

Bulletin de la Société Chimique de Paris.
Series 3, Vol. xxix., No. 1.

Pentafluoride of Iodine.—Henri Moissan.

Synthesis of the Alkaline Hydrosulphites, and the Anhydrous Alkaline Earths.—Henri Moissan.

Preparation and Properties of Silicide of Vanadium.—Henri Moissan and A. Holt.

Preparation and Properties of a New Silicide of Vanadium.—Henri Moissan and A. Holt.—The above four papers have been noticed already in this column.

The Action of Carbonic Oxide on Dissolved Ferricyanide of Potassium.—J. A. Muller.—Already inserted in full.

Examination of the Action of Carbonic Oxide on Mangano-, Cobalti-, Chromi-, and Platinocyanide of Potassium.—J. A. Muller.—Already inserted in full.

Localisation of the Normal Arsenic in Animals and Plants; its Origins.—Armand Gautier.—The author has not yet been able to detect arsenic in fishes, either in the eggs or in the roe. In birds it is not found in the eggs, but it is found in the feathers; the coloured portion of the tail-feathers of a peacock contained as much as 0·25 m.grm. of arsenic in 12 grms. of the substance. Arsenic is also present in the down from the breast of a goose. Again, arsenic was always found, in variable proportions, in fresh and salt-water algæ, but is much more plentiful in the latter.

Action of the Alcohols on Chloroacetate of Methylene.—M. Descudé.—Chloroacetate of methylene dissolves in the alcohols, but not without decomposition. Slowly in the cold and very rapidly when heated, hydrochloric acid is formed, while at the same time a complex reaction takes place, and, if the product obtained is rectified, we have a mixture of acetic ether of formal corresponding to the alcohol used, and water; all the chlorine of the chloroacetate having been eliminated in the state of hydrochloric acid. With methylic and ethylic alcohols, the reaction is extremely energetic, but the separation of the resulting products is difficult. The same is not the case with the higher homologues, and this reaction then constitutes a convenient and advantageous method for the preparation of the formals, considering how easily the chloroacetate, which need not be pure for this purpose, can be prepared.

Sulphurised and Nitrated Compounds Derived from Sulphide of Carbon.—Marcel Delépine.—VIII. *Thiosulphocarbamic Ethers Derived from Ammonia*, NH_2CS_2R.—The action of the halogen ethers on thiosulphocarbamate of ammonium engenders the thiosulphocarbamic ethers or dithiourethanes non-substituted for nitrogen, $NH_2.CS_2.NH_4+RX=NH_2.CS_2.R+NH_4X$. The known ethers of this category were the ethylic and isopropylic ethers. The author shows that the successive action of a halogenised ether, then of an acidylised derivative, gives acidyldithiourethanes; it was thought, therefore, that if we could start with a body containing two radicals, a closed chain would be formed. This is done easily with the α-halogen ether salts. IX. *Imidothiocarbonic Ethers*, $NH=C(SR)(SR')$.—(Already noticed).

New Derivatives of Dichlorised Phthalic Acid.—E. C. Severin.—The author describes three new derivatives of phthalic acid. Dichlorised dialcoylamido *m*-oxybenzoylbenzoic acid,—

$$C_6H_2Cl_2<\begin{matrix}COC_6H_3<\begin{matrix}OH\\N(CH_3)_2\end{matrix}\\COOH\end{matrix}$$

is obtained by melting together 100 grms. of dimethylamidometaphenol with 160 grms. of dichlorised phthalic anhydride. After three hours the whole forms a hard mass of a deep violet colour, which is pulverised and boiled with a very small quantity of alcohol; this dissolves the products that have not entered into the reaction. After draining, it is washed with cold alcohol, and then dissolved in boiling alcohol; on cooling, small colourless crystals are deposited fusing at 191°. A small quantity of rhodamine is formed also. Dichlorised dimethylamido-*m*-oxybenzylbenzoic acid is obtained by reduction in acetic acid by means of hydrochloric acid and zinc. The reduced acid crystallises in small white crystals fusing at 195°. Dichlorised dimethyl-amido-*m*-oxyanthraquinone is obtained by direct condensation with concentrated sulphuric acid, heated for one hour on the water-bath. The solution is poured into cold water, the precipitate collected and dissolved in acetic acid. On cooling, small flakey crystals are obtained of a bronze-violet colour, fusing at 185°.

MISCELLANEOUS.

The Chemical Society.—An Extraordinary General Meeting will be held in the Society's Rooms on Thursday, July 2nd, 1903, at 6 p.m., to consider the proposal of the Council to make certain alterations in By-law I., and in Circulars Nos. 2, 3, and 4 in the Appendix. The proposed changes are:—

I. To alter By-law I., p. 13, lines 3 and 4, by deleting the words "one year." The By-law at present reads:—"and he shall be entitled, so long as his annual subscription be not one year in arrear, to one copy of the annual publications of the Society."

II. To alter the Circulars in the Appendix as follows:—In Appendix, No. 2, "Letter notifying the Election of a Member," 5th and 6th lines, p. 26, delete the words "the Assistant Secretary." After the words "before admission," add the words "Payment should be made direct to the Society's Bankers, either by Cheque or Post Office Order crossed a/c 'Chemical Society.' Your remittance should be accompanied by the enclosed Form with your Name and Address filled in." In Appendix, No. 3, "Annual Circular Letter of Treasurer," delete from "If paid" to end of circular, and substitute the same words as added in No. 2. In Appendix, No. 4, "Annual Circular Letter of the Treasurer to Fellows who are two years in arrear of their Subscriptions," delete from "Payments should be made" to end of circular, and substitute the same words as added in No. 2.

MEETINGS FOR THE WEEK.

TUESDAY, 30th.—Faraday Society, 8. "The Present Position of the Theory of Electrolysis," by W. C. Dampier Wetham, F.R.S. "Chlorine Smelting, with Electrolysis," by James Swinburne, M.Inst.C.E. "Total and Free Energy of the Lead Accumulator," by R. A. Lehfeldt, D.Sc. "Electrolytic Apparatus," by F. Mollwo Perkin, Ph.D.

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